



# Service Manual

## Groundsmaster® 455-D

This publication provides the service technician with information for troubleshooting, testing, and repair of major systems and components on the Groundsmaster 455-D

REFER TO THE GROUNDMASTER 455-D OPERATOR'S MANUAL FOR OPERATING, MAINTENANCE AND ADJUSTMENT INSTRUCTIONS. Space is provided at the end of Chapter 2 in this publication to insert the Operator's Manuals and Parts Catalogs for your machine. Replacement Operator's Manuals are available by sending complete Model and Serial Number of traction unit and cutting unit to:

The Toro Company  
8111 Lyndale Avenue South  
Minneapolis, MN 55420

The Toro Company reserves the right to change product specifications or this publication without notice.



**This safety symbol means DANGER, WARNING, or CAUTION, PERSONAL SAFETY INSTRUCTION. When you see this symbol, carefully read the instructions that follow. Failure to obey the instructions may result in personal injury.**

**NOTE:** A NOTE will give general information about the correct operation, maintenance, service, testing or repair of the machine.

**IMPORTANT:** The IMPORTANT notice will give important instructions which must be followed to prevent damage to systems or components on the machine.



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Safety

Product Records  
and Manuals

Engine

Hydraulic System

Electrical System

Axles and Brakes

PTO System

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## Safety Instructions

The GROUNDMASTER 455-D conforms to the American National Standards Institute's safety standards for riding mowers when standard rear weight ballast is installed. Although hazard control and accident prevention partially are dependent upon the design and configuration of the machine; these factors are also dependent upon the awareness, concern, and proper training of the personnel involved in the operation, transport, maintenance, and storage of the machine. Improper use or maintenance of the machine can result in injury or death. To reduce the potential for injury or death, comply with the following safety Instructions.

**WARNING:** Engine exhaust contains carbon monoxide which is an odorless, deadly poison. Carbon monoxide is also known by the State of California to cause birth defects. Do not run engine indoors or in an enclosed area.



### CAUTION

**Obey the following safety instructions. Read and understand these instructions before operating the Groundmaster 455-D or doing maintenance, troubleshooting, testing, adjustments or repairs. Failure to comply with the safety instructions may result in personal injury.**

## Before Operating

1. Read and understand the Operator's Manual before starting, operating, maintaining or repairing the machine. Become familiar with the controls and know how to stop the machine and engine quickly. Replacement Operator's Manuals are available by sending complete Model and Serial Number of traction unit and cutting units to:

The Toro Company  
8111 Lyndale Avenue South  
Minneapolis, MN 55420

Use the Model and Serial Number when referring to your machine. If you have questions about this Service Manual, please contact:

The Toro Company  
Commercial Service Department  
8111 Lyndale Avenue South  
Minneapolis, MN 55420

2. Never allow children to operate the machine. Do not allow adults to operate machine without proper instruction. Only trained operators who have read this manual should operate this machine.

3. Never operate the machine when under the influence of drugs or alcohol.

4. Keep all shields, safety devices and decals in place. If a shield, safety device or decal is defective, illegible or damaged, repair or replace it before operating the machine. Also tighten any loose nuts, bolts or screws to ensure machine is in safe operating condition.

5. Always wear substantial shoes. Do not operate machine while wearing sandals, tennis shoes, sneakers or when barefoot. Do not wear loose fitting clothing that could get caught in moving parts and possibly cause personal injury. Wearing safety glasses, safety shoes,

long pants and a helmet is advisable and required by some local ordinances and insurance regulations.

6. Assure interlock switches are adjusted correctly so engine cannot be started unless traction pedal is in NEUTRAL and cutting unit is DISENGAGED.

7. Remove all debris or other objects that might be picked up and thrown by the blades or fast moving components from other attached implements. Keep all bystanders away from operating area.

8. Since diesel fuel is highly flammable, handle it carefully:

- A. Use an approved fuel container.
- B. Do not remove fuel tank cap while engine is hot or running.
- C. Do not smoke while handling fuel.
- D. Fill fuel tank outdoors and only to within an inch from the top of the tank, not the filler neck. Do not overfill.
- E. Wipe up any spilled fuel.

---

## While Operating

9. Sit on the seat when starting and operating the machine.

10. Before starting the engine:

- A. Engage the parking brake.
- B. Make sure traction pedal is in NEUTRAL and cutting decks are DISENGAGED. Move axle shift to HI or LO position.
- C. After engine is started, release parking brake and keep foot off traction pedal. Machine must not move. If movement is evident, the neutral return mechanism is adjusted incorrectly; therefore, shut engine off and adjust until machine does not move when traction pedal is released. Refer to Adjusting Traction Drive for Neutral in Chapter 4 - Hydraulic System.

11. Seating capacity is one person. Therefore, never carry passengers.

12. Do not run engine in a confined area without adequate ventilation. Exhaust fumes are hazardous and could possibly be deadly.

13. Check interlock switches daily for proper operation. Do not rely entirely on safety switches – use common sense. If a switch fails, replace it before operating the machine. The interlock system is for your protection, so do not bypass it. Replace all interlock switches every two years.

14. Using the machine demands attention and to prevent loss of control:

- A. Operate only in daylight or when there is good artificial light.
- B. Drive slowly. Avoid sudden stops and starts.
- C. Watch for holes or other hidden hazards.
- D. Look behind machine before backing up.
- E. Do not drive close to a sand trap, ditch, creek or other hazard.

F Reduce speed when making sharp turns and turning on a hillside.

15. Traverse slopes carefully. Do not start or stop suddenly when traveling uphill or downhill. Never shift axle when moving. Machine must be on a flat surface and / or brakes must be engaged to prevent freewheeling.

16. Operator must be skilled and trained in how to drive on hillsides. Failure to use caution on slopes or hills may cause loss of control and vehicle to tip or roll possibly resulting in personal injury or death.

17. When operating 4 wheel drive machine, always use the seat belt and ROPS together and have seat pivot retaining pin installed.

18. If engine stalls or loses headway and cannot make it to the top of a slope, do not turn machine around. Always back slowly straight down the slope.

19. Raise cutting decks and latch securely in transport position before driving from one work area to another.

20. DON'T TAKE AN INJURY RISK! When a person or pet appears unexpectedly in or near the mowing area, STOP MOWING. Careless operation, combined with terrain angles, ricochets, or improperly positioned guards can lead to thrown object injuries. Do not resume mowing until area is cleared.

21. Do not touch engine, muffler or exhaust pipe while engine is running or soon after it is stopped. These areas could be hot enough to cause burns.

22. If cutting deck strikes a solid object or vibrates abnormally, stop immediately, turn engine off, set parking brake and wait for all motion to stop. Inspect for damage. If damaged, repair or replace any components before operating.

23. Before getting off the seat:

- A. Set parking brake.
- B. Move traction pedal to neutral and axle shift to Hi or LO position.
- C. Disengage cutting decks and wait for blades to stop.

- D. Stop engine and remove key from switch.
- E. Do not park on slopes unless wheels are chocked or blocked.

24. Use only a rigid tow bar if it becomes necessary to tow machine. Use trailer for normal transport.

## While Doing Maintenance, Troubleshooting, Testing, Adjustments or Repairs

25. Before servicing or making adjustments, stop engine and remove key from the switch.

26. When changing attachments, tires or performing other service, use the correct blocks, hoists and jacks. Always chock or block the wheels and use jack stands or solid wood blocks to support the raised machine. If the traction unit is not properly supported by blocks or jack stands, the unit may move or fall resulting in injury.

27. Make sure machine is in safe operating condition by keeping all nuts, bolts and screws tight.

28. Make sure all hydraulic line connectors are tight, and all hydraulic hoses and lines are in good condition before applying pressure to the system.

29. Keep body and hands away from pin hole leaks or nozzles that eject high pressure hydraulic fluid. Use cardboard or paper to find hydraulic leaks. Hydraulic fluid escaping under pressure can penetrate skin and cause injury. Fluid accidentally injected into the skin must be surgically removed within a few hours by a doctor familiar with this form of injury or gangrene may result.

30. Before disconnecting or performing any work on the hydraulic system, all pressure in system must be relieved by lowering cutting units to the ground and stopping engine.

31. If major repairs are ever needed or assistance is desired, contact an Authorized Toro Distributor.

32. To reduce potential fire hazard, keep engine area free of excessive grease, grass, leaves and dirt. Clean protective screen on back of machine frequently.

33. If engine must be running to perform maintenance or an adjustment, keep hands, feet, clothing and other parts of the body away from cutting units and other moving parts. Keep all bystanders away.

34. Do not overspeed the engine by changing governor setting. To assure safety and accuracy, have an Authorized Toro Distributor check maximum engine speed.

35. Shut engine off before checking or adding oil to the crankcase.

36. Disconnect battery before servicing the machine. If battery voltage is required for troubleshooting or test procedures, temporarily connect the battery.

37. At the time of manufacture, the machine conformed to the safety standards for riding mowers. Ballast weight, mounted to rear of traction unit, is required for machine to conform to safety standard. DO NOT remove ballast weight at any time. To assure optimum performance and continued safety certification of the machine, use genuine Toro replacement parts and accessories. Replacement parts and accessories made by other manufacturers may result in non-conformance with the safety standards, and the warranty may be voided.







# Product Records and Manuals

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## Product Records

Record information about your Groundsmaster 455-D on the Equipment Operation and Service History Report Form. Use this information when referring to your machine.

Insert the Operator's Manuals and Parts Catalogs for your Groundsmaster 455-D at the end of this section.

# Equivalents and Conversions

## Decimal and Millimeter Equivalents

Fractions	Decimals	mm	Fractions	Decimals	mm
1/64	0.015625	— 0.397	33/64	0.515625	— 13.097
1/32	0.03125	— 0.794	17/32	0.53125	— 13.494
3/64	0.046875	— 1.191	35/64	0.546875	— 13.891
1/16	0.0625	— 1.588	9/16	0.5625	— 14.288
5/64	0.078125	— 1.984	37/64	0.578125	— 14.684
3/32	0.09375	— 2.381	19/32	0.59375	— 15.081
7/64	0.109275	— 2.778	39/64	0.609375	— 15.478
1/8	0.1250	— 3.175	5/8	0.6250	— 15.875
9/64	0.140625	— 3.572	41/64	0.640625	— 16.272
5/32	0.15625	— 3.969	21/32	0.65625	— 16.669
11/64	0.171875	— 4.366	43/64	0.671875	— 17.066
3/16	0.1875	— 4.762	11/16	0.6875	— 17.462
13/64	0.203125	— 5.159	45/64	0.703125	— 17.859
7/32	0.21875	— 5.556	23/32	0.71875	— 18.256
15/64	0.234375	— 5.953	47/64	0.734375	— 18.653
1/4	0.2500	— 6.350	3/4	0.7500	— 19.050
17/64	0.265625	— 6.747	49/64	0.765625	— 19.447
9/32	0.28125	— 7.144	25/32	0.78125	— 19.844
19/64	0.296875	— 7.541	51/64	0.796875	— 20.241
5/16	0.3125	— 7.938	13/16	0.8125	— 20.638
21/64	0.328125	— 8.334	53/64	0.828125	— 21.034
11/32	0.34375	— 8.731	27/32	0.84375	— 21.431
23/64	0.359375	— 9.128	55/64	0.859375	— 21.828
3/8	0.3750	— 9.525	7/8	0.8750	— 22.225
25/64	0.390625	— 9.922	57/64	0.890625	— 22.622
13/32	0.40625	— 10.319	29/32	0.90625	— 23.019
27/64	0.421875	— 10.716	59/64	0.921875	— 23.416
7/16	0.4375	— 11.112	15/16	0.9375	— 23.812
29/64	0.453125	— 11.509	61/64	0.953125	— 24.209
15/32	0.46875	— 11.906	31/32	0.96875	— 24.606
31/64	0.484375	— 12.303	63/64	0.984375	— 25.003
1/2	0.5000	— 12.700	1	1.000	— 25.400
1 mm = 0.03937 in.			0.001 in. = 0.0254 mm		

## U.S to Metric Conversions



	To Convert	Into	Multiply By
<b>Linear Measurement</b>	Miles	Kilometers	1.609
	Yards	Meters	0.9144
	Feet	Meters	0.3048
	Feet	Centimeters	30.48
	Inches	Meters	0.0254
	Inches	Centimeters	2.54
	Inches	Millimeters	25.4
<b>Area</b>	Square Miles	Square Kilometers	2.59
	Square Feet	Square Meters	0.0929
	Square Inches	Square Centimeters	6.452
	Acre	Hectare	0.4047
<b>Volume</b>	Cubic Yards	Cubic Meters	0.7646
	Cubic Feet	Cubic Meters	0.02832
	Cubic Inches	Cubic Centimeters	16.39
<b>Weight</b>	Tons (Short)	Metric Tons	0.9078
	Pounds	Kilograms	0.4536
	Ounces (Avdp.)	Grams	28.3495
<b>Pressure</b>	Pounds/Sq. In.	Kilopascal	6.895
<b>Work</b>	Foot-pounds	Newton-Meters	1.356
	Foot-pounds	Kilogram-Meters	0.1383
	Inch-pounds	Kilogram-Centimeters	1.152144
<b>Liquid Volume</b>	Quarts	Liters	0.9463
	Gallons	Liters	3.785
<b>Liquid Flow</b>	Gallons/Minute	Liters/Minute	3.785
<b>Temperature</b>	Fahrenheit	Celsius	1. Subtract 32°
			2. Multiply by 5/9

# Torque Specifications

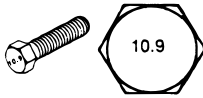
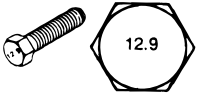
Use these torque values when specific torque values are not given. DO NOT use these values in place of specified values.

The torque values listed below are for lubricated threads. Plated threads are considered to be lubricated.

## Capscrew Markings and Torque Values - U.S. Customary

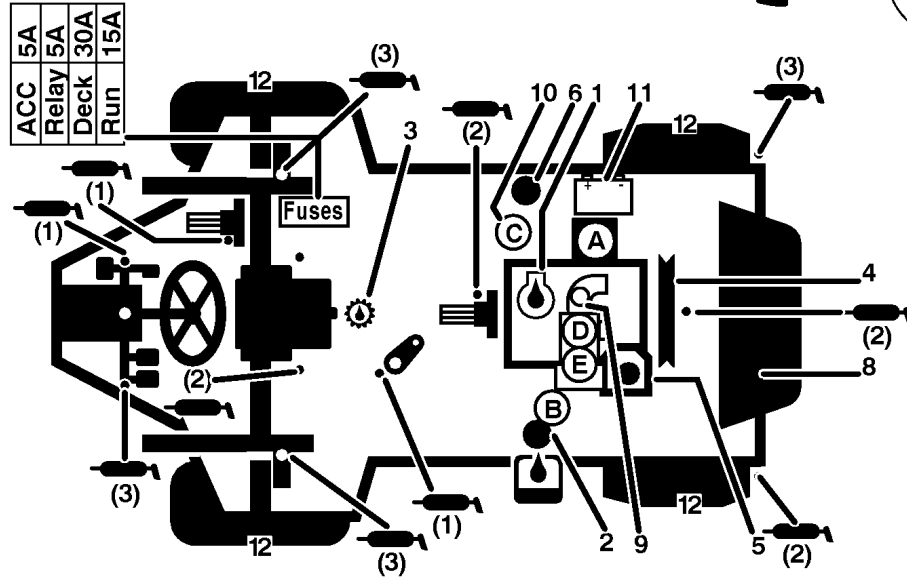
SAE Grade Number	5				8			
Capscrew Head Markings								
Capscrew Body Size	Capscrew Torque - Grade 5				Capscrew Torque - Grade 8			
	ft-lb	Cast Iron Nm	Aluminum ft-lb	Nm	ft-lb	Cast Iron Nm	Aluminum ft-lb	Nm
1/4-20 -28	7 9	9 12	6 7	8 9	11 13	15 18	9 10	12 14
5/16-18 -24	15 17	20 23	12 14	16 19	22 24	30 33	18 19	24 25
3/8-16 -24	30 30	40 40	20 25	25 35	40 45	55 60	30 35	40 45
7/16-14 -20	45 50	60 65	35 40	45 55	65 70	90 95	50 55	65 75
1/2-13 -20	70 75	95 100	55 60	75 80	95 110	130 150	75 90	100 120
9/16-12 -18	100 110	135 150	80 85	110 115	140 155	190 210	110 125	150 170
5/8-11 -18	135 155	180 210	110 120	150 160	190 215	255 290	150 170	205 230
3/4-10 -16	240 270	325 365	190 210	255 285	340 380	460 515	270 300	365 410
7/8-9 -14	360 390	490 530	280 310	380 420	550 610	745 825	440 490	600 660
1-8 -14	530 590	720 800	420 480	570 650	820 890	1100 1200	660 710	890 960

## Capscrew Markings and Torque Values – Metric

Commercial Steel Class 8.8					10.9				12.9			
Capscrew Head Markings												
Thread Diameter mm	Capscrew Torque - Class 8.8				Capscrew Torque - Class 10.9				Capscrew Torque - Class 12.9			
	Cast Iron ft-lb	Aluminum Nm	Cast Iron ft-lb	Aluminum Nm	Cast Iron ft-lb	Aluminum Nm	Cast Iron ft-lb	Aluminum Nm	Cast Iron ft-lb	Aluminum Nm	Cast Iron ft-lb	Aluminum Nm
6	5	9	4	7	9	14	7	11	9	14	7	11
7	9	14	7	11	14	18	11	14	18	23	14	18
8	18	25	14	18	23	32	18	25	27	36	21	28
10	30	40	25	30	45	60	35	45	50	70	40	55
12	55	70	40	55	75	105	60	80	95	125	75	100
14	85	115	65	90	120	160	95	125	145	195	110	150
16	130	180	100	140	175	240	135	190	210	290	165	220
18	170	230	135	180	240	320	185	250	290	400	230	310

# Maintenance Schedules

## GM 455-D 2WD QUICK REFERENCE AID



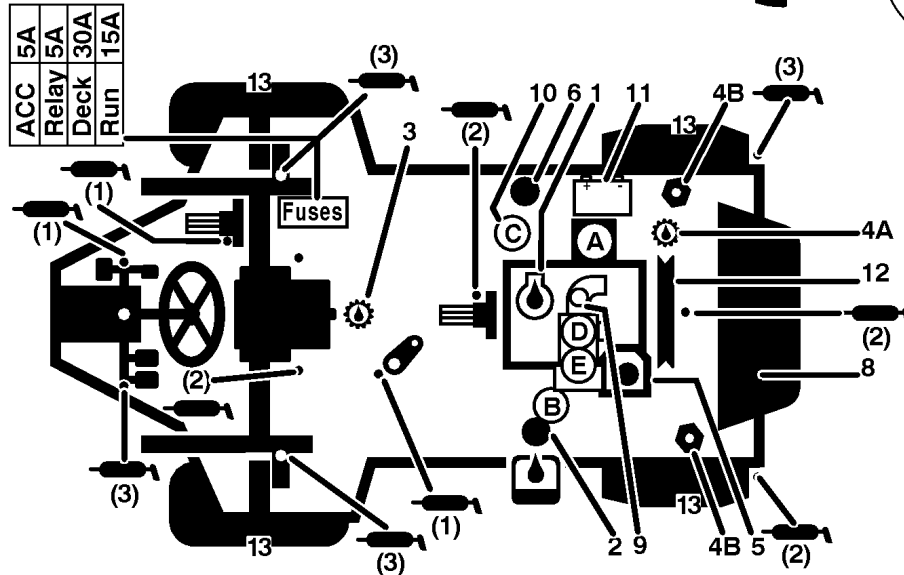
### CHECK/SERVICE

1. ENGINE OIL LEVEL/FILL
2. HYDRAULIC OIL LEVEL/FILL
3. FRONT AXLE OIL LEVEL/FILL
4. FAN BELT
5. COOLANT LEVEL/FILL
6. FUEL-DIESEL ONLY
7. GREASE POINTS (23)
8. RADIATOR SCREEN
9. AIR FILTER SERVICE INDICATOR
10. WATER SEPARATOR/FUEL FILTER
11. BATTERY
12. TIRE PRESSURE (1-1.5 BAR/15-20 PSI)

### FLUID SPECIFICATIONS/CHANGE INTERVALS

See operator's manual for initial changes.	FLUID TYPE		CAPACITY		CHANGE INTERVAL		FILTER PART NO.
	---	---	L	USA	FLUID	FILTER	
ENGINE OIL	SAE 15W-40 CD		5	5.3 QT	100 HRS	100 HRS	74-7970 (A)
HYD. CIRCUIT OIL	Mobil DTE 26		24.6	6.5 G	800 HRS	800 HRS	86-3010 (B)
AXLE OIL	SAE 80-90 E.P.				800 HRS		
FUEL FILTER						400 HRS	76-5220 (C)
PRIMARY AIR FILTER						SEE SERVICE INDICATOR	93-9162 (D)
SAFETY AIR FILTER						SEE OPERATOR'S MANUAL	93-9163 (E)
FUEL	>32°F 0° C	NO. 2-D	53	14 GAL.	Drain and flush, 800 hours		
	<32°F 0° C	NO. 1-D					
COOLANT	93-7213 50/50 PEUGEOT ANTI-FREEZE		13.25	3.5 GAL.	Drain and flush, 1500 hours or 2 years, whichever occurs first.		

# GM 455-D 4WD QUICK REFERENCE AID



## CHECK/SERVICE

1. ENGINE OIL LEVEL/FILL
2. HYDRAULIC OIL LEVEL/FILL
3. FRONT AXLE OIL LEVEL/FILL
4. REAR AXLE OIL
  - A. FILL
  - B. CHECK (2)
5. COOLANT LEVEL/FILL
6. FUEL-DIESEL ONLY
7. GREASE POINTS (23)
8. RADIATOR SCREEN
9. AIR FILTER SERVICE INDICATOR
10. WATER SEPARATOR/FUEL FILTER
11. BATTERY
12. FAN BELT
13. TIRE PRESSURE (1-1.5 BAR/15-20 PSI)

## FLUID SPECIFICATIONS/CHANGE INTERVALS

See operator's manual for initial changes.	FLUID TYPE		CAPACITY		CHANGE INTERVAL		FILTER PART NO.
			L	USA	FLUID	FILTER	
ENGINE OIL	SAE 15W-40 CD		5	5.3 QT	100 HRS	100 HRS	74-7970 (A)
HYD. CIRCUIT OIL	Mobil DTE 26		24.6	6.5 G	800 HRS	800 HRS	86-3010 (B)
AXLE OIL	SAE 80-90 E.P.				800 HRS		
FUEL FILTER						400 HRS	76-5220 (C)
PRIMARY AIR FILTER						SEE SERVICE INDICATOR	93-9162 (D)
SAFETY AIR FILTER						SEE OPERATOR'S MANUAL	93-9163 (E)
FUEL	>32°F 0° C	NO. 2-D	53	14 GAL.	Drain and flush, 800 hours		
	<32°F 0° C	NO. 1-D					
COOLANT	93-7213 50/50 PEUGEOT ANTI-FREEZE		13.25	3.5 GAL.	Drain and flush, 1500 hours or 2 years, whichever occurs first.		





EQUIPMENT OPERATION AND SERVICE HISTORY REPORT  
for  
GROUNDMASTER® 455-D

TORO Model and Serial Number: \_\_\_\_\_ - \_\_\_\_\_

Engine Numbers: \_\_\_\_\_

Transaxle Numbers: \_\_\_\_\_

Rotary Deck Numbers: \_\_\_\_\_ - \_\_\_\_\_

Date Purchased: \_\_\_\_\_ Warranty Expires \_\_\_\_\_

Purchased From: \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

Contacts:            Parts            \_\_\_\_\_            Phone \_\_\_\_\_

                         Service            \_\_\_\_\_            Phone \_\_\_\_\_

                         Sales            \_\_\_\_\_            Phone \_\_\_\_\_

*See your TORO Distributor/Dealer for other Publications, Manuals, and Videos from The TORO Company.*

## GROUNDMASTER® 455-D Maintenance Schedule

Minimum Recommended Maintenance Intervals:

Maintenance Procedure	Maintenance Interval & Service Type:				
Inspect Air Filter, Dust Cup, and Baffle	Every 50hrs	Every 100hrs	Every 200hrs	Every 400hrs	Every 800hrs
Lubricate All Grease Fittings	<i>A Level Service</i>				
Check Cutting Unit Gear Box Oil Level					
‡ Change Engine Oil and Filter					
Check Battery Level and Connections		<i>B Level Service</i>			
Inspect Cooling System Hoses					
Service Air Cleaner Filter Element					
† Inspect PTO and Cutting Unit Belts					
‡ Check Electric Deck Clutches Adjustment					
‡ Check Electric PTO Clutch Adjustment			<i>C Level Service</i>		
† Torque Wheel Lug Nuts					
Replace Fuel Filter					
Check Front Transaxle Oil level					
Check Rear Axle Oil level (4wd)					
Inspect Fuel Lines and Connections				<i>D Level Service</i>	
‡ Check Engine RPM (idle and full throttle)					
† Inspect Engine Fan Belt					
Inspect Engine Timing Belt (see note below)					
Drain and Clean Fuel Tank					
Change Hydraulic Oil					
‡ Replace Hydraulic Oil Filter					
Change Front Transaxle Oil					
Pack Rear Axle Bearings (2wd)					
Change Rear Axle Oil (4wd)					<i>E Level Service</i>
Check Rear Wheel Toe-in					
† Initial break in at 10 hours					
‡ Initial break in at 50 hours					
Replace Moving Hydraulic Hoses					
Replace Safety Switches					
Cooling System - Flush/Replace Fluid					
Replace PTO Belts/Cutter Deck Belts					

### **Annual Recommendations:**

*Items listed are recommended every 1500 hours or 2 years whichever occurs first.*

See Operator's and Service Manual for specifications and procedures)

**NOTE:** Replace Timing Belt if worn, cracked or oil soaked. A new Timing Belt should be installed any time the Belt is removed or loosened.



# GROUNDMASTER® 455-D Daily Maintenance Check List

Unit Designation: \_\_\_\_\_

Daily Maintenance:(duplicate this page for routine use)

TORO ID#: \_\_\_\_\_ - \_\_\_\_\_

<b>Maintenance Check Item</b>	<b>Daily Maintenance Check For Week Of _____</b>						
	MON	TUES	WED	THURS	FRI	SAT	SUN
	____ HRS	____ HRS	____ HRS	____ HRS	____ HRS	____ HRS	____ HRS
✓ Safety Interlock Operation							
✓ Brake Operation							
✓ Engine Oil Level							
✓ Fuel Level							
✓ Cooling System Fluid Level							
Drain Water/Fuel Separator							
✓ Optional Air Filter Precleaner							
✓ Radiator & Screen for Debris <sup>1</sup>							
✓ Unusual Engine Noises <sup>2</sup>							
✓ Unusual Operating Noises							
✓ Hydraulic System Oil Level							
✓ Hydraulic Hoses for Damage							
✓ Fluid Leaks							
✓ Tire Pressure							
✓ Instrument Operation							
✓ Cutting Unit Safety Doors							
✓ Height-of-Cut Adjustment							
Clean Deck Belt area <sup>1</sup>							
✓ Condition of Blades							
Lubricate All Grease Fittings <sup>3</sup>							
Touch-up damaged paint							

<sup>1</sup> = Use only low pressure compressed air for debris removal. **Do not use water.**

<sup>2</sup> = Check Glow Plugs and Injector Nozzles, if hard starting, excess smoke, or rough running is noted.

<sup>3</sup> = Immediately after every washing, regardless of the interval listed.

**Notation for areas of concern:** Inspection performed by: \_\_\_\_\_

Item	Date	Information
1		
2		
3		
4		
5		
6		
7		

(See Operator's and Service Manual for specifications and procedures)

# GROUNDMASTER® 455-D Supervisor Maintenance Work Order

Date: \_\_\_\_\_

(duplicate this page for routine use)

Unit Designation:	TORO I.D. #:	Service to perform (circle): <b>A B C D E Other</b>
Hours:		
Technician:		

Remarks:

## A -Service (every 50 hours)

- ☐ Inspect Air Filter, Dust Cup, & Baffle
- ☐ Lubricate All Grease Fittings
- ☐ Check Cutting Unit Gear Box Oil

_____
_____
_____
_____
_____
_____
_____

## B -Service (every 100 hours)

- ☐ Change Engine Oil and Filter
- ☐ Check Battery Level and Connections
- ☐ Inspect Cooling System Hoses

<b>A-Service</b> required	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

## C -Service (every 200 hours)

- ☐ Service Air Cleaner Filter Element
- ☐ Inspect PTO and Cutting Unit Belts
- ☐ Check Electric Deck Clutches Adjustment
- ☐ Check Electric PTO Clutch Adjustment
- ☐ Torque Wheel Lug Nuts

**A and B Service** required

_____
_____
_____
_____

## D -Service (every 400 hours)

- ☐ Replace Fuel Filter
- ☐ Check Front Transaxle Oillevel
- ☐ Check Rear Axle Oil level (4wd)
- ☐ Inspect Fuel Lines and Connections
- ☐ Check Engine RPM (Idle/Full Throttlet)

**A, B, and C Service** required

_____
_____
_____
_____

## E -Service (every 800 hours)

- ☐ Inspect Engine Fan Belt
- ☐ Inspect Engine Timing Belt
- ☐ Drain and Clean Fuel Tank
- ☐ Change Hydraulic Oil & Filter
- ☐ Change Front Transaxle Oil
- ☐ Pack Rear Axle Bearings (2WD)
- ☐ Change Rear Axle Oil (4WD)
- ☐ Check Rear Wheel Toe-in

**A, B, C, and D Service** required

## Other - Annual Service and Specials

- ☐ Replace Moving Hoses
- ☐ Replace Safety Switches
- ☐ Coolant System - Flush/Replace Fluid
- ☐ Replace PTO/ Cutter Deck Belts

_____
_____
_____
_____
_____
_____
_____

(See Operator's and Service Manual for specifications and procedures)



## Chapter 3

# Engine

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# Introduction

The following pages give information about specifications, maintenance, troubleshooting, testing and repair of the diesel engine used in the Groundsmaster® 455-D mowers.

Most repairs and adjustments require tools which are commonly available in many service shops. Special tools are described in the Special Tools section. The use of some specialized test equipment is explained, however, the cost of the test equipment and the specialized nature of some repairs may dictate that the work be done at a qualified diesel engine repair facility.

Service and repair parts for the Peugeot engine used in the Groundsmaster 455-D are supplied through TORO Distributors. Repair parts may be ordered by TORO Part Number. If no parts list is available be sure to provide your dealer or distributor with the TORO Model Number and Serial Number.

A plate, riveted to the left-hand side of the engine block carries the Engine Serial Number. Always include the engine serial number with parts orders and warranty claims.

# Identification and Specifications

## General Specifications

Item	Specification
Engine Type	Peugeot XUD9AI, 4 cycle, water cooled, 4 cylinder, vertical in-line cylinders, single overhead cam, indirect injection, naturally aspirated.
Compression ratio	23.5 : 1
Governor:	Mechanical centrifugal type integral with fuel injection pump.
Governor Adjustment	3000 ± 50 RPM no load 1600 +100/-0 RPM idle speed
Engine Rotation	Counterclockwise when facing flywheel.
Crankshaft	Forged steel, induction hardened bearing surfaces, 5 main bearing supports.
Cylinder Block	Cast iron with integral cylinder liners.
Cylinder Head	Cast aluminum material with single overhead camshaft.
Timing Drive	The camshaft, water pump and fuel injection pump are driven from the front end of the crankshaft through belt drive.
Piston and Piston Rings	Pistons are aluminum alloy castings with free-floating wrist pin.
Lubrication	Full pressure feed by gear type pump.
Oil Filter	Full flow, cartridge type, paper element with bypass.
Oil Capacity	5 liters (5.3 qt.), including oil filter.
Lubricating Oil	API class CD SAE 15W-40
Oil Pressure	0.5 Bar (7 PSI) minimum
Fuel Requirements	No. 2 diesel fuel (ASTM No. 2-D).
Fuel Filter	Replaceable paper element.
Crankcase Ventilation	Connected to intake manifold with PCV valve.
Cooling System	Water is circulated through the cylinder block and head by a centrifugal water pump mounted at the front of the cylinder block. The water pump operates at 1.05 times engine speed. Water flow is 92 liters/min. at 2500 engine RPM.
Firing Order (NO. 1 CYL. IS ON FLYWHEEL END)	1 - 3 - 4 - 2
Electrical System	12 volt, negative ground, 55 AMP alternator with integral regulator. 12 volt - 1.4 Kw starter motor with integral solenoid, pinion shaft type.

## Cylinder Head

Cylinder head height **h** is measured with the camshaft in place fitted with two bearing caps.

**h** is measured on the oil seal lip contact diameter (the largest diameter).

**h** nominal: 157.40 to 157.75 mm

Maximum permissible bow on bottom of cylinder head:  
0.07 mm (camshaft must turn freely).

Maximum permissible gasket face machining: .14 mm in relation to the measured **h** nominal.

Cylinder heads machined undersize are stamped **R** in the area (**a**):

After machining gasket face, the following operations must be done:

1. Valve seat machining to re-establish correct recess (see Valve Recess in this section).
2. Replacement of swirl chambers by repair dimension and correction of their protrusion (see Swirl Chambers in this section).
3. Fitting of 0.4 mm thick compensation washers under the valve springs (to match cylinder head machining).

Cylinder heads manufactured with oversize camshaft bearings (+0.5) are stamped **1** in the area (**a**)

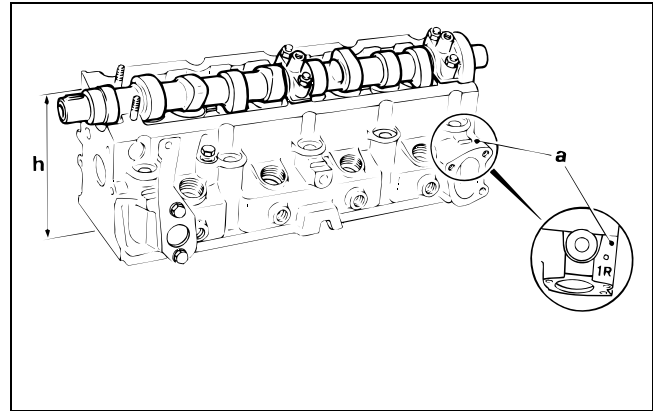


Figure 2

## Cylinder Head Gasket

Thickness identification:

Units: mm

Identification (c)	Identification (b)	Thickness
No notch	2 notches	1.61
	3 notches	1.73

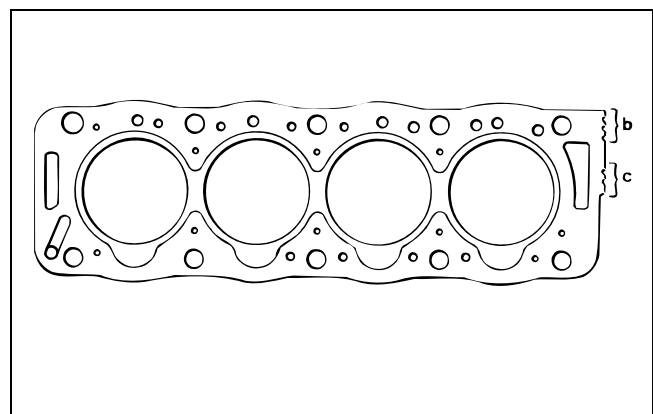


Figure 3

Camshaft

Camshafts with 0.5 mm oversize bearings\* are identified by a yellow paint ring (d) between the cams of No. 1 cylinder.

\* NOTE: These camshafts are installed only on exchange engines, and can be obtained on special order.

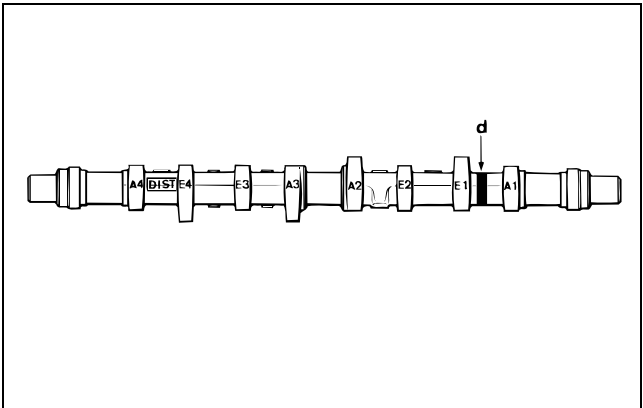


Figure 4

Valves

Units: mm

	Intake	Exhaust
Min. Length l	112.2	
$\varnothing a^{+0}_{-0.015}$	8.005	7.985
$\varnothing b \pm 0.1$	38.5	33
a	90°	90°

Intake: Faces x and y can machined a maximum of 0.2 mm

Exhaust: No machining is permissible.

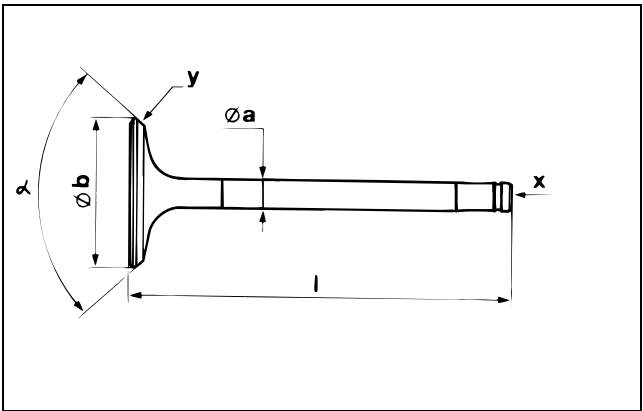


Figure 5

Valve Recess

Units: mm

	Intake	Exhaust
c	0.5 to 1.05	0.9 to 1.45

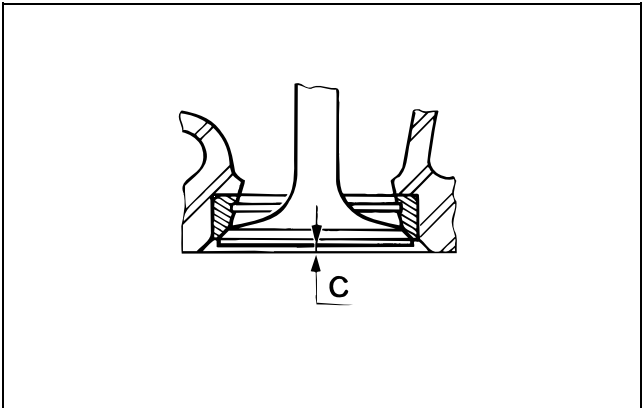


Figure 6

Valve Springs

Units: mm

	Spring
$\varnothing d$	29
P1: daN e1	18 42.4

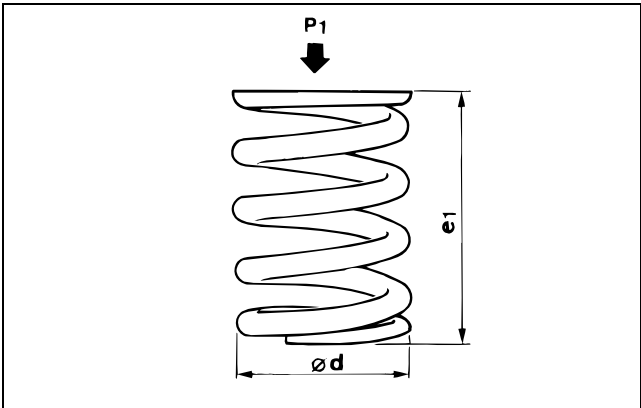


Figure 7

Valve Guides

Units: mm

	$\varnothing f$	$\varnothing g$	h	j	$\varnothing k$
Tolerance	0 - 0.011	+ 0.032 0	$\pm 0.25$	$\pm 0.50$	0 + 0.2
Production	14.02 14.13	13.981 14.051			
Repair 1	14.29	14.211	52.00	36.50	8.02
Repair 2	14.59	14.511			

$\varnothing k$  is obtained by machining after fitting in the cylinder head

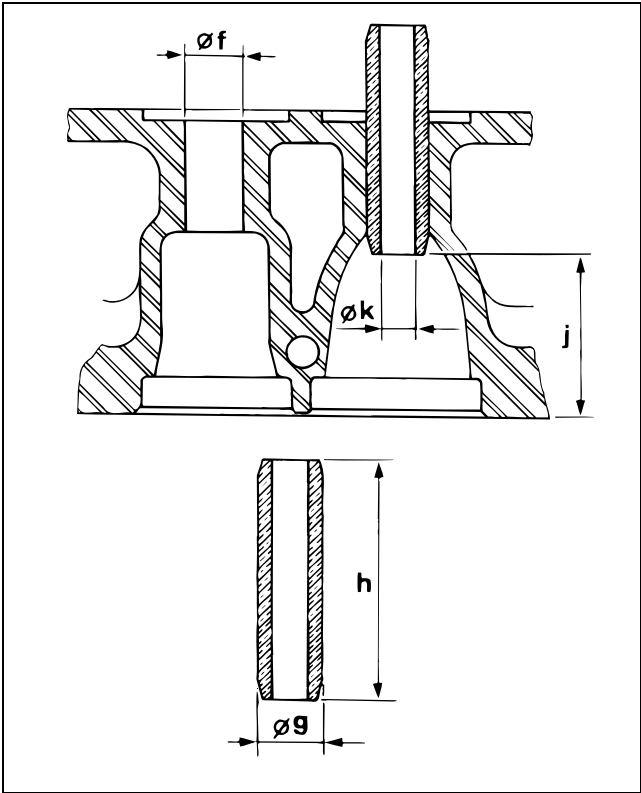


Figure 8



## Valve Seats

Units: mm

Intake				
	$\varnothing a$	$\varnothing b$	c	d
Tolerance	0 - 0.025	$\pm 0.025$	0 - 0.1	$\pm 0.15$
Production	40.161 40.361	40 40.2	6.25 6.45	8.267 8.467
Repair 1	40.461	40.3	6.45	8.467
Repair 2	40.661	40.5	6.45	8.467

Units: mm

Exhaust				
	$\varnothing a$	$\varnothing b$	c	d
Tolerance	0 - 0.025	$\pm 0.025$	0 - 0.1	$\pm 0.15$
Production	34.137 34.337	34 34.2	6.05 6.25	8.15 8.35
Repair 1	34.437	34.3	6.25	8.35
Repair 2	34.637	34.5	6.25	8.35

After fitting valve seats into the cylinder head, machine them according to drawings (Fig. 9).

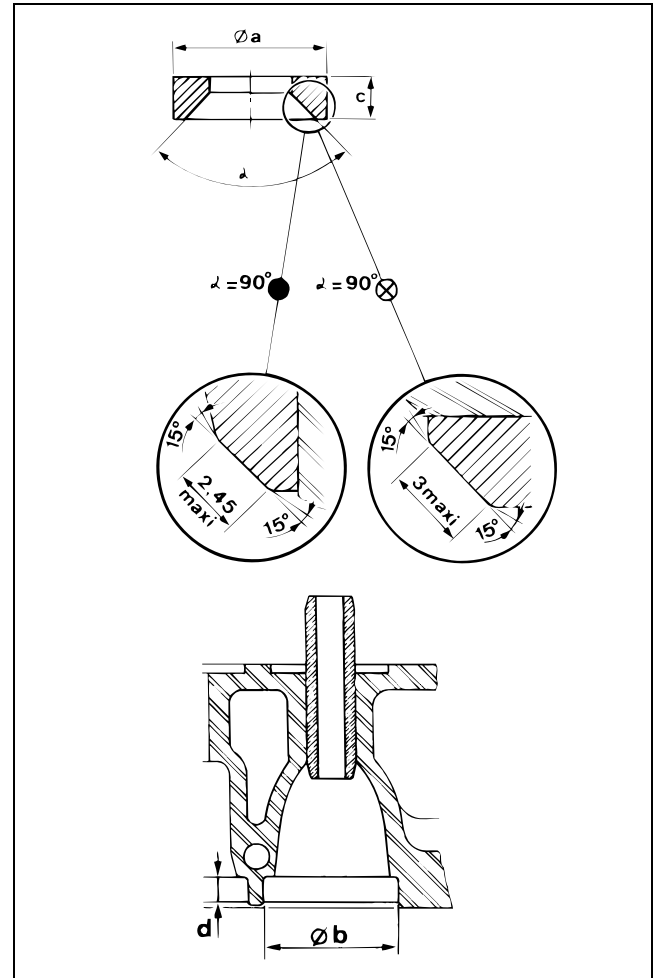


Figure 9

## Swirl Chambers

Units: mm

	$\varnothing e$	$\varnothing f$	g	h
Tolerance	+ 0.099 - 0.060	+ 0.039 + 0	+ 0.020 - 0.025	+ 0.02 - 0.04
Production	32.05 32.25	32 32.2	4 4.1	3.9 4
Repair 1	32.45	32.4	4.2	4.1
Repair 2	32.65	32.6	4.3	4.2

The protrusion j must be between 0 and 0.03 mm  
Dimension j is obtained by machining faces (x) and (y)

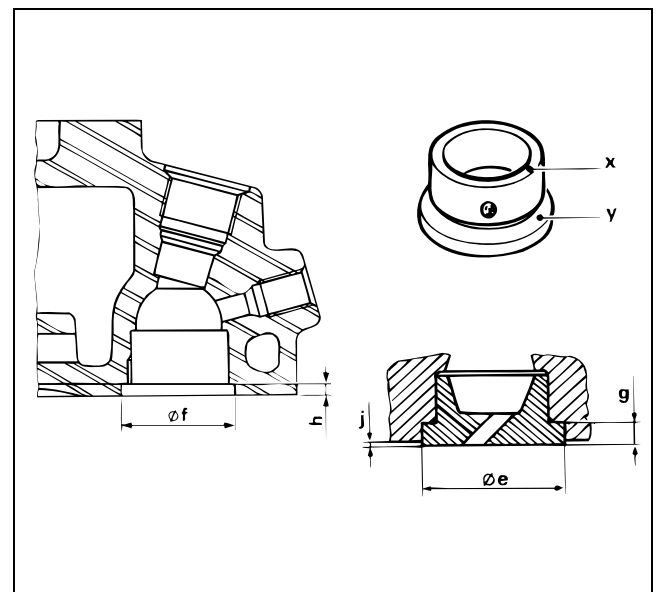


Figure 10

# Cylinder / Piston Matching

Units: mm

	Identification (x)	CYLINDER $\varnothing a$ Tolerance: + 0.018 - 0	PISTON $\varnothing b$ Tolerance: $\pm 0.009$
Production	None	83	82.93
	A1	83.03	82.96
Repair 1	R1	83.20	83.13
Repair 2	R2	83.50	83.43
Repair 3	R3	83.80	83.73

NOTE: The piston  $\varnothing b$  must be measured at dimension c.

C	25.00
---	-------

NOTE: The repair dimension (x) is stamped on the cylinder block and pistons.

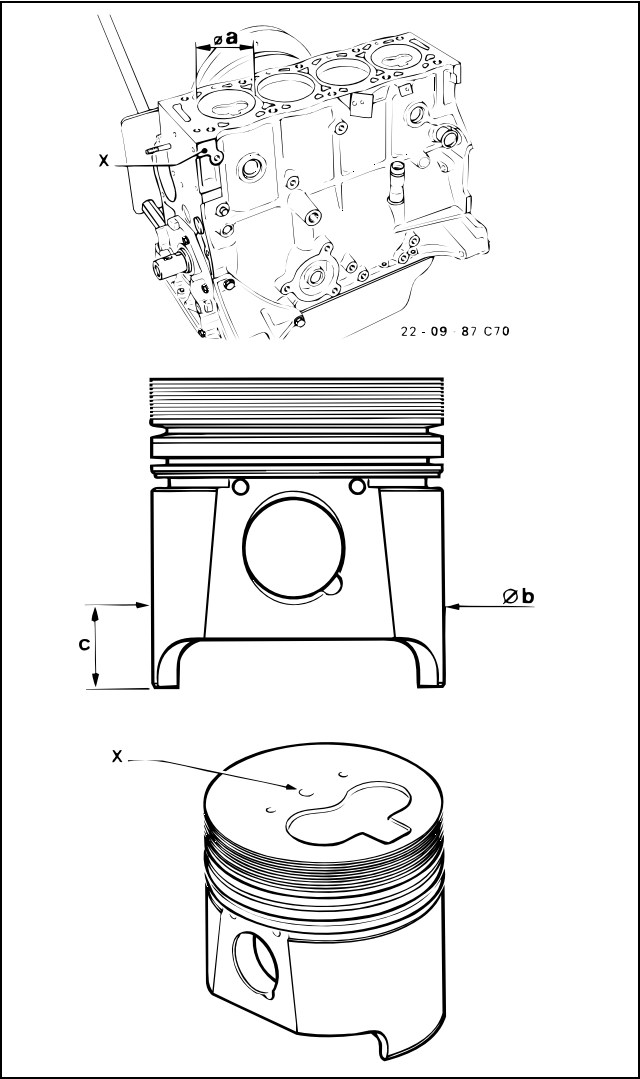


Figure 11

# Piston Pin

Units: mm

$\varnothing$ external	24.994 to 25
$\varnothing$ internal	13.8 to 14.1

## Crankshaft

Units: mm

Crank Pins and Journals				
	øa	b	øc	d
Tolerance	- 0 - 0.016	± 0.003	- 0 - 0.019	± 0.003
Production	50.00	1.827	60.00	1.842
Repair 1	49.70	1.977	59.70	1.992

NOTE: Repair 1 size connecting rod and main bearing shells can be identified by white paint (1) on the edge of the shell.

Units: mm

End Float		
	No. 2 Journal	Half Shell Thickness
	e	f
Tolerance	+ 0.05 0	± 0.025
Production	26.60	2.305
Repair 1	26.80	2.405
Repair 2	26.90	2.455
Repair 3	27.00	2.505

Units: mm

Oil Seal Contact Surface	
	øg
Tolerance	- 0 - 0.087
Production	90.00
Repair 1	89.80

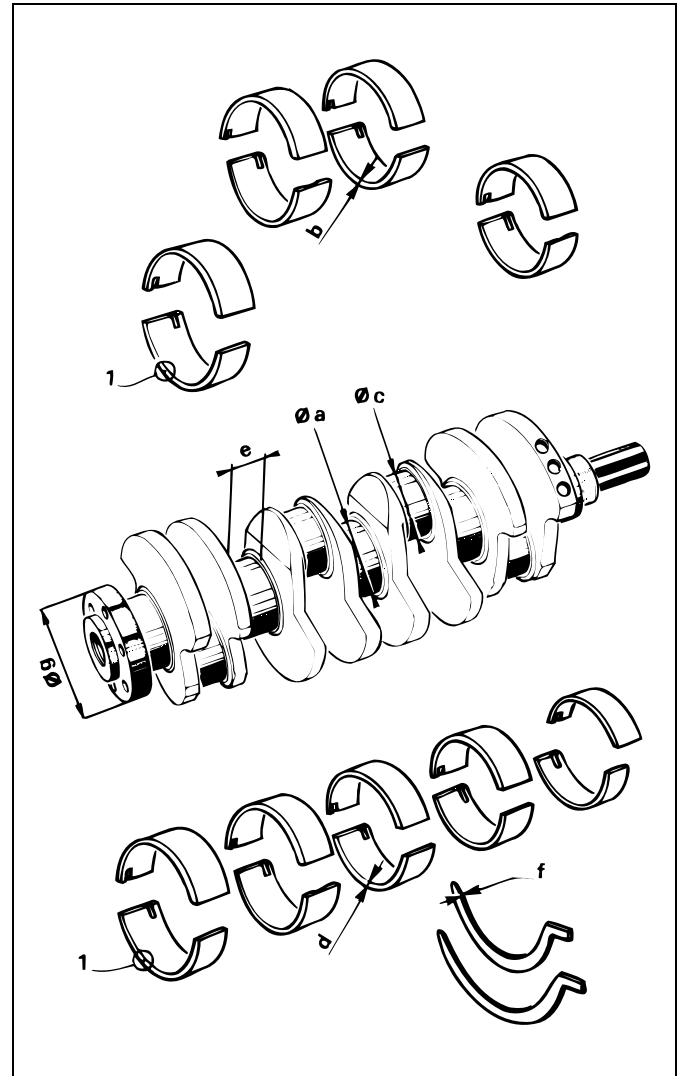


Figure 13

Engine

## Tightening Torques

Part	Nm	Kgm	ft-lb
Connecting rod end caps	50	5	37
Camshaft bearing caps	17.5	1.8	13
Camshaft gear	40	4	30
Coolant pump	15	1.5	11
* Crankshaft pulley	40 + 60°	4 + 60°	30 + 60°
Cylinder head bolts pre-tightening * tightening	30 70 + 120°	3 7 + 120°	22 52 + 120°
Cylinder head cover	10	1	7
Flywheel	50	5	36
Glow plugs	22	2.2	16
Injector pump gear	47	4.7	33
Injector into Cylinder Head	90	9	66
Main bearing caps	70	7	52
Oil pump	20	2	15
Oil seal carrier, timing gear end	15	1.5	11
Sump to block	20	2	15
Timing belt tensioner	15	1.5	11
Water drain plug	25	2.5	18
Oil drain plug	37	3.7	27
Tension roller pin nut	17	1.7	12
Manifold screws	22	2.2	16
Alternator bracket	17	1.7	12

\* NOTE: 40 + 60° is tighten to 40 Nm then an additional 60° (60 degrees) of rotation (one flat of bolt head)

# Special Tools

NOTE: Order special tools from the *TORO SPECIAL TOOLS AND APPLICATIONS GUIDE (COMMERCIAL PRODUCTS)*. Some tools may be listed in the

Groundsmaster 455-D Parts Catalog. Some tools may also be available from a local supplier.

---

## TOR4033 Overhaul Tool Set

This tool kit includes tools required for overhauling the engine. TOR4035 Tune-Up Set will also be required if overhauling the engine.

- TOR80504A1 Extension (Fig. 24)
- TOR80110H Indicator Holder (Fig. 25)
- TOR80110DZ 2mm Shim Cutoff Gauge (Fig. 23)
- TOR80504A2 Indicator Holder (Fig. 30)
- TOR80110GY Extension Rod Adapter (Fig. 24)
- TOR70153A1 Main Seal Installer (Fig. 18)
- TOR70153A2 Main Seal Installer Shims (Fig. 19)
- TOR70153C Rear Main Seal Installer (Fig. 20)
- TOR70153D Front Cover Seal Installer (Fig. 21)

---

## TOR4035 Tune-Up Set

This tool kit includes tools required for doing timing belt replacement, injection pump timing, injector removal and camshaft seal replacement.

- TOR976697 Camshaft Seal Installer (Fig. 31)
- TOR2437T Dial Indicator (Fig. 16)
- TOR70153N Flywheel TDC Locator Pin (Fig. 22)
- TOR80117AM Injector Pump  
Timing Tool Kit (Fig. 26)
- TOR80117EZ Crankshaft Rotating Wrench (Fig. 27)
- TOR80149 Injector Socket (Fig. 28)

### **TOR2437T Dial Indicator**

This dial indicator may be used with TOR80110H, TOR80117AM and TOR80504A2 to accomplish any of the following tasks: for checking the protrusion of the swirl chambers, valve recess and measurement for cylinder head gasket selection, adjusting the timing of the injection pump and for checking the crankshaft and float.

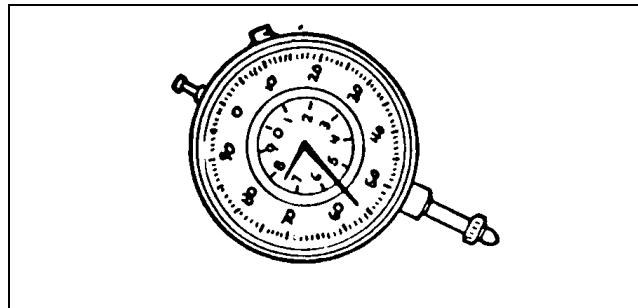


Figure 16

### **TOR4024T Valve Spring Compressor**

This tool is used to compress valves for removal.

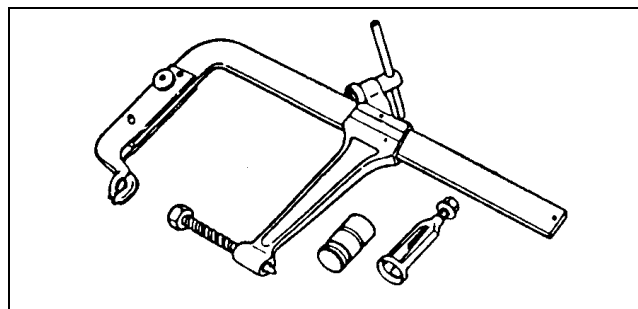


Figure 17

### **TOR70153A1 Main Seal Installer**

Used to install the two side seals to the no. 1 main bearing cap.

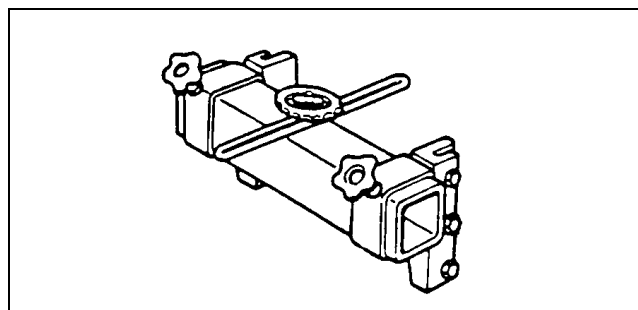


Figure 18

### **TOR70153A2 Shim Set**

Used with main seal installer TOR70153A1.

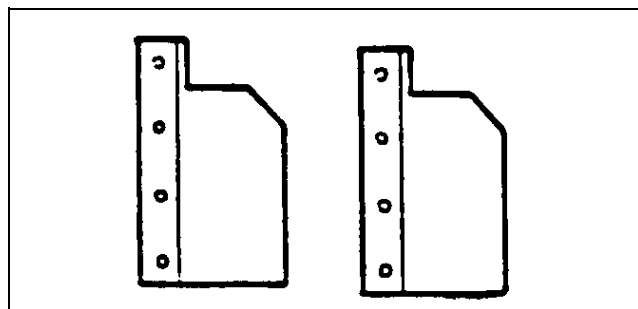


Figure 19

### **TOR70153C Rear Main Seal Installer**

Used with a small hammer to install new rear main oil seal.

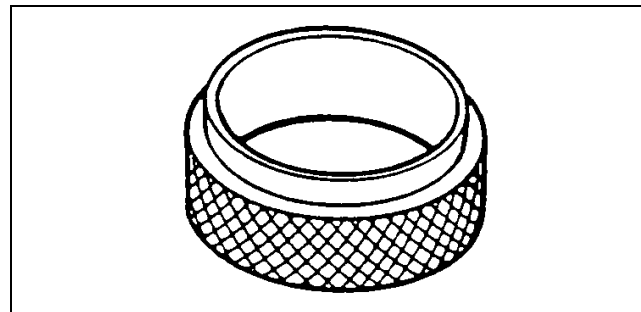


Figure 20

### **TOR70153D Front Cover Seal Installer**

Used with a small hammer to install new front crankshaft seal.

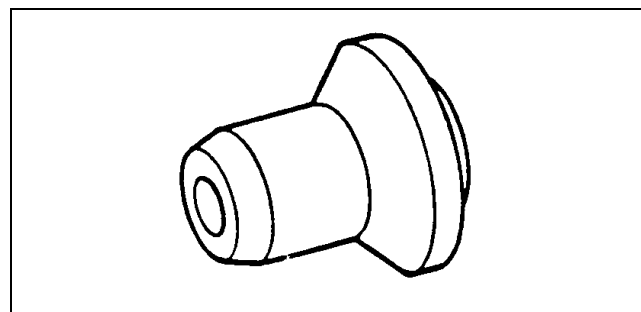


Figure 21

### **TOR70153N Flywheel T.D.C. Locator Pin**

Used to set injection pump timing.

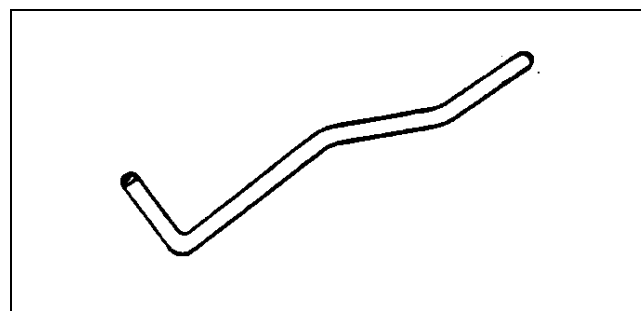


Figure 22

### **TOR80110DZ 2mm Shim Cut Off Gauge With Cut Off Shim**

Used to gage and cut off new side seals to 2mm height.

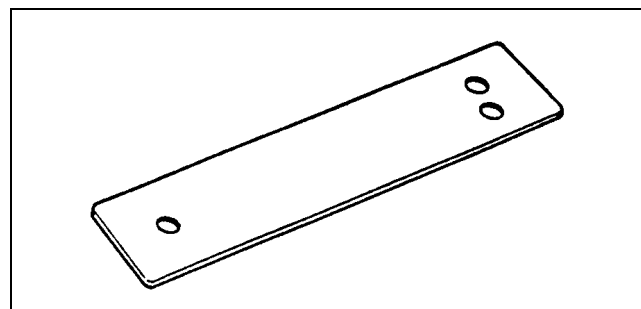


Figure 23

### **TOR80110GY Extension Rod and Adapter**

Used with TOR 80504A1 and TOR80504A2 to check crankshaft end float.

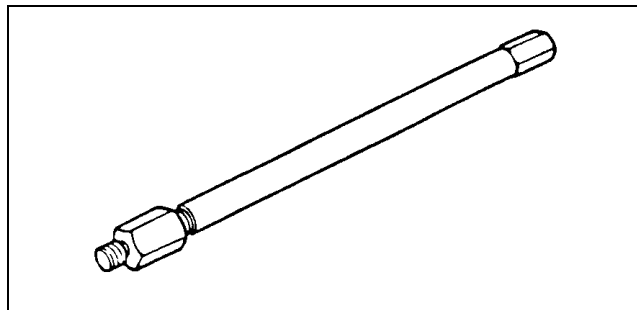


Figure 24

### **TOR80110H Indicator Holder**

Block used to hold dial indicator to check protrusion of swirl chambers, valve recess and measurement for cylinder head gasket selection.

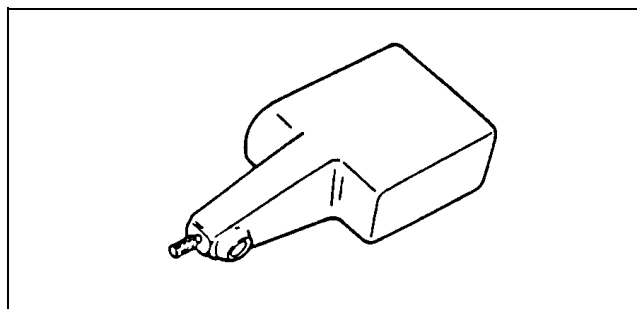


Figure 25

### **TOR80117AM Timing Tool Kit For Roto Diesel DPC Pump**

Used with dial indicator to adjust timing of injection pump.

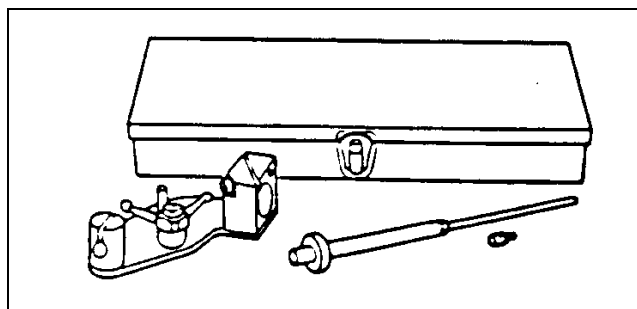


Figure 26

### **TOR80117EZ Crankshaft Rotating Wrench**

Used with a 1/2" drive ratchet wrench to turn the crankshaft.

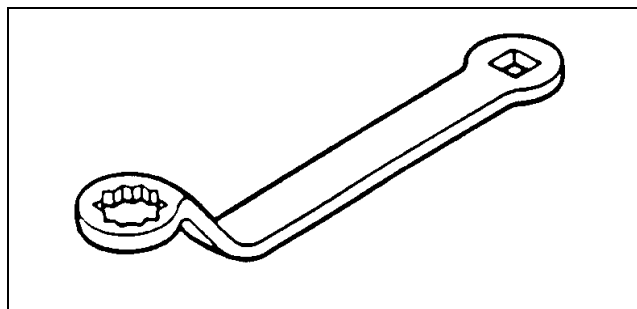


Figure 27



### **TOR80149 Injector Socket**

Used to remove and install fuel injectors.

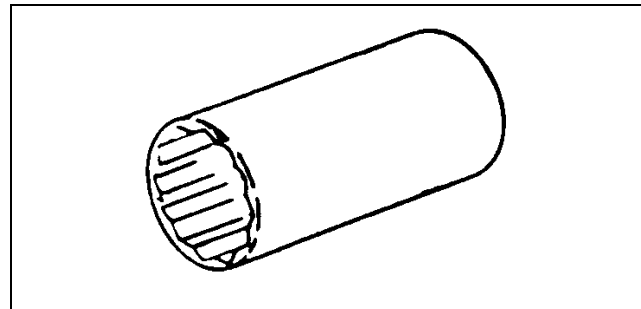


Figure 28

### **TOR80504A1 Extension**

Used with TOR 80110GY and TOR 80504A2 to check crankshaft end float.

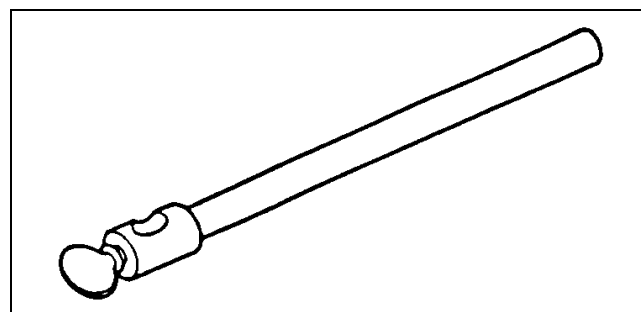


Figure 29

### **TOR 80504A2 Indicator Holder**

Used with TOR80110GY and TOR 80504A1 to check crankshaft end float.

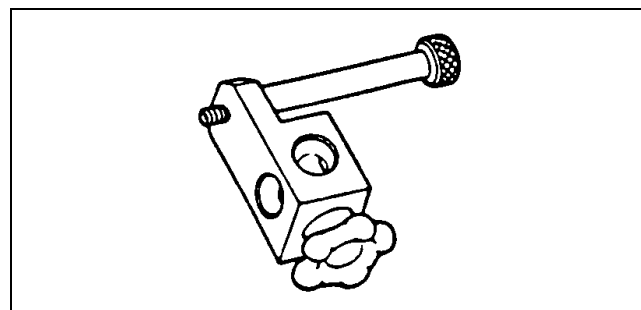


Figure 30

### **TOR976697 Camshaft Seal Installer**

Used to install camshaft seal.

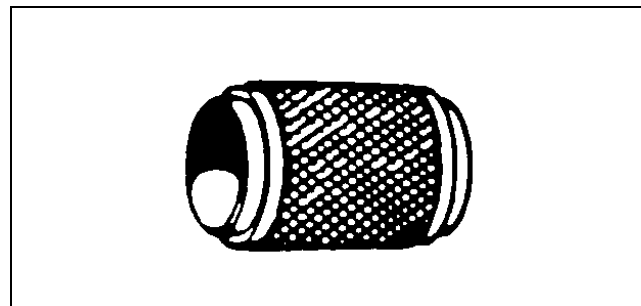


Figure 31

**.0149 - Cylinder Head Separating Levers  
(Make Locally)**

Used to remove cylinder head (qty. 2 required).

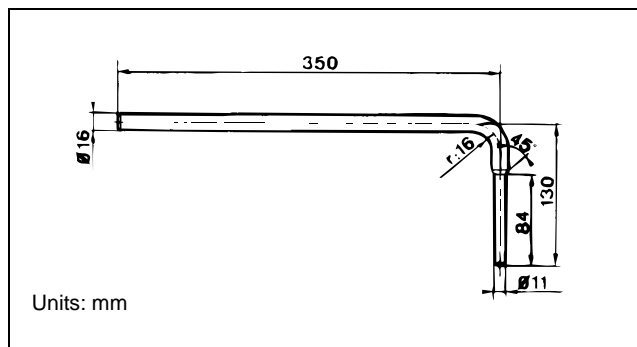


Figure 32

**TOR70153H Injector Pump Gear Puller**

Loosen the nut on the injector pump gear, then use this tool to loosen the pulley from the tapered shaft on the injector pump.

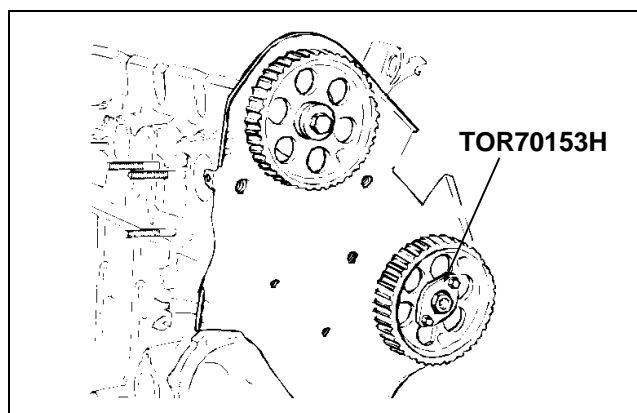


Figure 33

# Adjustments

---

## Valve Clearance Adjustment

(See Valve Clearance Adjustment in the Engine Overhaul Section.)

---

## Engine Speed Adjustments

Maximum fuel flow and speed adjustments are sealed and should only be unsealed by a CAV Lucas ROTO-DIESEL service dealer.

---

## Throttle Cable Adjustments

The throttle control lever at the operator's station must not touch the end of the slot during full range of motion from idle (SLOW) to full engine RPM (FAST).

Adjust throttle cable at injection pump so throttle lever on injection pump operates at full range of motion without throttle control lever at operator's station touching end of slot at either FAST or SLOW position.

# Troubleshooting

## Alternator

Problem	Possible Causes
Alternator is not charging.	Alternator belt loose. Charging circuit defective. Energizing circuit defective. Brushes worn or seized. Rotor winding defective. Stator winding defective. Regulator defective.
Output low or irregular.	Alternator belt loose. Charging circuit defective. Energizing circuit defective. Brushes worn or seized. Rotor winding defective. Stator winding defective. Regulator defective. Rotor partially short-circuited. Stator partially short-circuited. Rectifier diode defective. Rectifier diode short-circuited.
Battery voltage too high.	In-line diode defective. Regulator defective. Poor connections.
Alternator noisy.	Rectifier diode short-circuited. Belt worn. Alternator mounting loose. Alternator pulley loose. Worn bearings.

## Fuel Injectors

Problem	Possible Cause	Correction
Bad spray pattern	Carbon deposit around the orifice	Clean
	Scored nozzle seat	Replace injector
	Needle damaged	Replace injector
Leaking injector	Foreign matter jammed between nozzle seat and needle	Clean
	Nozzle seat out-of-true	Replace injector
Needle seized or showing seizing marks	Water in fuel	Drain water and flush fuel feed system (1)
	Copper gasket not replaced	Replace gasket at each repair
	Injector nut too tight on injector body	Tighten injector nut (1)
Leakage collector fills too quickly	Leak between upper bearing face of nozzle and bearing face of injector body:	
	Foreign matter between bearing faces	Clean
	Unevenness	Replace injector
Blue needle point	Incorrect injection pump timing	Replace injector and adjust pump timing again
End of injector body corroded	Running temperature of engine too low	Check thermostat
	Intermittent operation	Run machine longer. Do not start and stop engine.

(1) In these cases, replace the injector

## Fuel Injection Pump

Problem	Possible Cause	Correction
Engine has no power	Defective fuel supply Incorrect pump timing Incorrect spray, or injector pressure out of adjustment Air intake restriction Insufficient automatic advance Discharge rates too low	Check filter cartridge and pipes Correct timing Check, clean and adjust injectors Check hoses and air cleaner Have pump repaired Have pump repaired
Idling too fast	Idling stop out of adjustment Throttle cable out of adjustment Governor out of adjustment	Adjust stop and fast idling control Adjust throttle cable Have pump repaired
Maximum speed too high	Max. speed stop out of adjustment Jammed discharged valve Blocked pump governor	Have pump repaired Have pump repaired Have pump repaired
Engine will not accelerate	Defective fuel supply Seized pump plunger Broken pump plunger spring Hard discharge valve Seized feed pump Accelerator linkage defective	Check filter cartridge and pipes Have pump repaired Have pump repaired Have pump repaired Drain water from tank, pipes and filter – have pump repaired Repair linkage
Engine emits smoke	Air getting into feed system Defective fuel supply Incorrect pump timing Incorrect spray, or injectors out of adjustment Insufficient automatic advance Discharge rates too high Air intake restriction	Check gaskets and pipes Check filter cartridge Correct timing Check, clean and adjust injectors Have pump repaired Have pump repaired Check hoses and air cleaner

Problem	Possible Cause	Correction
Engine will not start	No preheating No fuel supply  Defective solenoid valve Seized pump plunger Discharge valve blocked in “stop” position Seized feed pump	Check glow plugs and relay Make sure tank is not empty Check filter element and pipes Check system bleeding Check electric stop solenoid Have pump repaired Have pump repaired Drain water from tank, pipes and filter – repair pump
Irregular engine speed	Defective fuel supply Carbon fouled injectors Unequal discharge rates Faulty governor	Check filter cartridge and pipes Check, clean and adjust injectors Have pump repaired Have pump repaired
Noisy engine	Incorrect pump timing Blocked automatic advance Automatic advance to far advanced	Correct timing Have pump repaired Have pump repaired
Engine stalls at idling	Air getting into fuel system Idling stop out of adjustment Jammed discharge rate	Check gaskets and pipes Adjust idling stop Have pump repaired
Vibrating engine	Unequal discharge rate Air in fuel system Defective fuel injector Jammed discharge valve	Have pump repaired Check fuel lines and clamps Check injectors Have pump repaired
Engine will not stop	Key switch defective Defective electric stop solenoid	Replace key switch Check electric stop solenoid

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## Low Power

Problem	Possible Causes
Engine does not give full power	Injection pump timing Seized piston rings Defective injector(s) Air intake restricted Valve leaks Clogged fuel filter Injection pipe restriction due to excessive tightening of unions Defective injection pump
Irregular idling	Defective injection pump Air getting into fuel system Idling stop out of adjustment Leaky injection pipe unions
Speed fall-Off	Clogged fuel filter Defective injection pump
Engine speed rises to maximum	Defective injection pump Throttle cable jammed



# Noisy Engine

Problem	Possible Causes
Knocking	<div>Loose main bearings</div> <div>Broken part</div> <div>Leakage return collector clogged</div> <div>Lifters out of adjustment</div> <div>Foreign matter in a cylinder</div> <div>Seized injector</div> <div>Injection pump timing</div> <div>Sheared glow plug</div> <div>Timing out of adjustment</div>
Whistling, blowing	<div>Leaking cylinder head gasket</div> <div>Leaky glow plug</div> <div>Valve seats</div> <div>Leaky injector</div>

Engine

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## Pre-heating

Problem	Possible Causes
Glow plug does not glow red hot	Faulty glow plug Faulty glow plug relay Damaged wiring or connector All four glow plugs burnt out / ends melted – injection pump timing out of adjustment (engine overheating) See Chapter 5 - Electrical System

## Smoke During Operation

Problem	Possible Causes
Black	Defective injector Injection pump out of adjustment Injection pump timing Air intake restricted Inlet chambers clogged Not enough advance
Grey	Defective injector Injection pump timing Air intake restricted Not enough advance
Blue-Grey	Defective injector Injection pump timing Too much oil
Blue	Too much oil Wear
White	Injection pump timing Cylinder head gasket Cold engine

Engine

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## Starting Problems

Problem	Possible Causes
Engine will not start and emits black smoke	Air intake obstructed  Defective injectors  Lack of compression (seized rings, damaged or worn valve seats, or general wear)  Injection pump timing
Engine will not start and emits white smoke	Leaking cylinder head gasket
Engine will not start and does not emit any smoke	Frozen fuel  Injection pump does not work  Leaking injection pipe unions  Injection valve blocked  No preheating  Empty fuel tank  Feed pipe obstructed  Air getting in pipes  Tank vent plugged  Injection pump needs re-priming  Shutdown control jammed in "stop" position
Starter does not crank or cranks slowly	Battery discharged  Oil too thick  Engine seized  Faulty starter  Faulty wiring

# Testing and Inspection

## Injection Pump Timing

(See Timing of Injection Pump in the Engine Overhaul section.)

## Glow Plug Test



### CAUTION

Be careful while handling or testing glow plugs. Glow plugs become extremely hot. Accidental contact with the heated plug tip could cause personal injury.

1. Disconnect the wire lead(s) to the glow plug.
2. Remove the glow plug.
3. Inspect the glow plug for signs of a burnt glow plug end tube.

NOTE: If the metal of the glow plug end is melted, it is a sign of cylinder overheating.

4. Connect the positive (+) battery terminal to the glow plug terminal, and the negative (-) battery terminal to the plug body (Fig. 34). If the glow plug glows red-hot in 9 to 12 seconds, the glow plug is operating correctly. DO NOT leave on more than 20 seconds.

5. Replace any glow plugs that do not operate correctly.

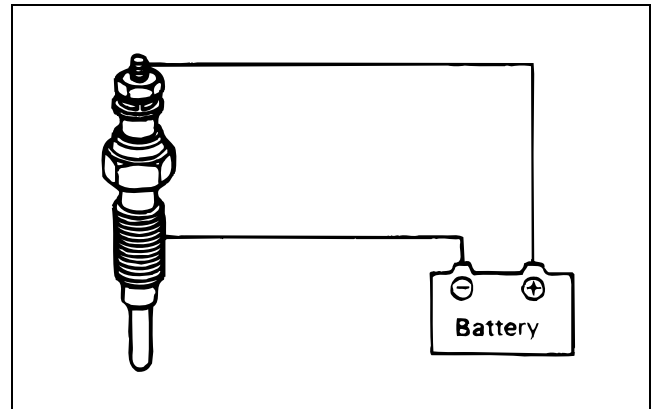


Figure 34

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## Compression Test

Minimum cylinder compression is 20 bar (290 psi) at 200 rpm (normal cranking speed). The engine should be warm - coolant temperature of 50° C (120° F).

**IMPORTANT: DO NOT put oil into the combustion chamber before performing a compression test. Damage may result because of “hydraulic” forces acting upon the piston and connecting rod.**

1. Remove the glow plug lead wires and glow plugs from all four cylinders.
2. Insert a compression gauge adapter into the glow plug hole.
3. Connect a high pressure compression gauge to the adapter.
4. Disconnect the fuel stop solenoid electrical connector or hold the fuel stop lever in the stop position to prevent fuel delivery during the compression test. This will prevent wash-down of the cylinders and inaccurate readings.
5. Crank the engine with the starter motor until you get a stable gauge reading.
6. If the pressure is less than 20 bar (290 psi) it will be necessary to find the cause of low compression.
7. Repeat the test for the other three cylinders. Difference between cylinders should be no more than 5 bar (70 psi).
8. Connect the fuel stop solenoid electrical connector.
9. Install the glow plugs.

## Injector Tests

There are several tests to examine the condition of the injection nozzles. These tests require the use of a nozzle tester and nozzle tester adapter.



### CAUTION

**The nozzle tester forces fuel from the nozzle under extremely high pressure. Always point the nozzle tip away from yourself and any other personnel. Contact with the fuel stream, even though it appears to be a mist can cause fuel to penetrate clothing and skin. If fuel is injected into the skin get proper medical attention from a doctor immediately. A serious infection or other reaction can develop if the injury is not properly treated. Tighten all adapter fittings to prevent leaks. If a leak is suspected, use a piece of cardboard, not your hands to search for a leak.**

**To prevent possible injury, wear eye protection when operating the nozzle tester.**

**IMPORTANT: Always use fresh filtered fuel in the nozzle tester. Use of dirty fuel can damage the precision parts of the injector nozzle. It is a good practice to:**

1. Bolt the tester securely to the test bench.
2. Use a drain pan to catch fuel.
3. Flush the adapter by pumping the handle of the tester slowly several times before attaching the nozzle to be tested.

### Injection Pressure Test

The diesel engine requires that fuel be sprayed into the combustion chamber at a precise point in the compression stroke. The point at which this fuel injection occurs is determined by the injection timing. If the nozzle is

defective, damaged or adjusted incorrectly, starting failures, low power output, or engine knocking can occur.

1. Securely fasten the nozzle to the adapter.
2. Pump the handle several times to purge air from the nozzle mechanism.
3. Allow pressure to dissipate before performing the test.
4. Operate the pump handle slowly and observe the gauge to determine the pressure at which the nozzle opens and the fuel is sprayed.
5. Verify that starting pressure is within the following limits:
  - “C” injectors  $115 \pm 5$  bar or  $\text{kg/cm}^2$  ( $1668 \pm 70$  psi)
  - “D” injectors  $130 \pm 5$  bar or  $\text{kg/cm}^2$  ( $1885 \pm 70$  psi)
6. Starting pressure can be adjusted by adding or removing shims from the nozzle. A 0.10 mm shim thickness will cause a 10 bar or  $\text{kg/cm}^2$  (140 psi) starting pressure difference.
7. Repeat the test after installing shim to verify that a correct opening pressure has been obtained.

### Chattering Test

Proper and free operation of the nozzle valve can be determined by the chattering test.

1. Securely fasten the nozzle to be tested to the adapter.
2. Operate the pump handle slowly (1 - 2 strokes per second). As the pump pressure reaches the starting pressure the nozzle valve will chatter or buzz as it opens and closes rapidly. A nozzle which does not chatter or buzz may be the result of a binding or bent nozzle valve.

## Nozzle Leakage Test

A nozzle that leaks fuel from the nozzle orifice must be replaced.

1. Securely fasten the nozzle to the adapter.
2. Wipe all fuel from the nozzle.
3. Operate the pump until the pressure is approximately 20 bar or  $\text{kg/cm}^2$  (280 psi) below opening pressure. Maintain this pressure to the nozzle.
4. Watch for leaks where the threaded nozzle body threads into the retaining nut. Leaks in this area would indicate a bad seat between the distance piece and/or the body or nozzle assembly.
5. If leakage occurs, verify that the body is tightly fastened in the retaining nut. If the leak continues, replace the nozzle.
6. While pressure is being applied, watch for an accumulation of fuel at the tip of the nozzle (Fig. 35). A small amount of fuel may be present due to a previous chattering test - this would be normal. If the fuel accumulates and drips down during the test (about ten seconds) the nozzle assembly is defective and must be replaced.

## Spray Test

For proper combustion, the nozzle must effectively atomize the injected fuel.

1. Operate the pump handle quickly (4 - 6 strokes per second).
2. Observe the injector nozzle spray. The spray pattern should be finely atomized in a broad, straight stream (Fig. 36).
3. If the nozzle fails to spray properly, it must be cleaned, repaired or replaced.

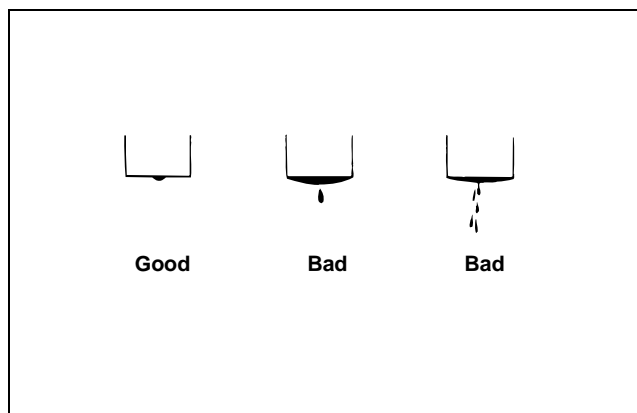


Figure 35

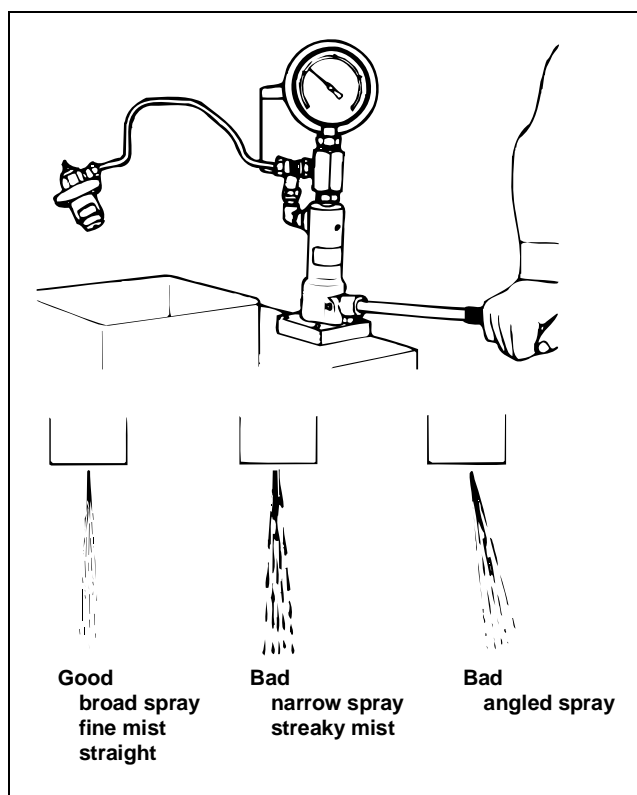


Figure 36



## Injection Pump Testing

Calibration of fuel delivery volumes, pressure and distribution between pump barrels should be performed by a professional diesel engine service shop. Special test fixtures and equipment are required.

It is possible to determine if the fuel injection pump requires service through a process of elimination using other fuel system tests. The following test procedure will help isolate fuel system difficulties.

1. Make sure that fuel is being supplied to the injector pump.
2. Check the operating condition of the injection nozzles to make sure that the injection pressure is correct.
3. Make sure that the injection pump is providing sufficient fuel pressure to operate the nozzle by performing the following procedures:
  - A. Loosen the fuel delivery pipe from the number one nozzle.
  - B. Remove the nozzle from the cylinder head.
  - C. Connect the fuel delivery pipe to the nozzle assembly so the tip of the nozzle is pointed away from the engine. Tighten the fitting securely.

D. Put the throttle control in the FAST position. Turn the ignition key to the START position to crank the engine. Observe the nozzle.



### CAUTION

**The injection pump forces fuel from the nozzle under extremely high pressure. Always point the nozzle tip away from yourself and any other personnel. Contact with the fuel stream, even though it appears to be a mist can cause fuel to penetrate clothing and skin. If fuel is injected into the skin get proper medical attention from a doctor immediately. A serious infection or other reaction can develop if the injury is not properly treated. Tighten all adapter fittings to prevent leaks. If a leak is suspected, use a piece of cardboard, not your hands to search for a leak.**

If the nozzle produces an atomized mist of fuel the injector pump for that cylinder is operating properly. Failure of the nozzle to inject fuel can indicate a injection pump cylinder that is not operating correctly.

5. Repeat the test for the other cylinders.

---

## Thermostat Test

If the engine overheats or runs too cool, and a faulty thermostat is suspected, the thermostat should be tested.

1. Remove the thermostat.
2. Put the thermostat in a container of water with a thermometer and heat the water.

Starts to open at: 81° C (178° F)  
7 mm (0.28 in.) full open at 88° C (190° F)

3. If the thermostat fails to open, only partially opens, or sticks, it should be replaced.

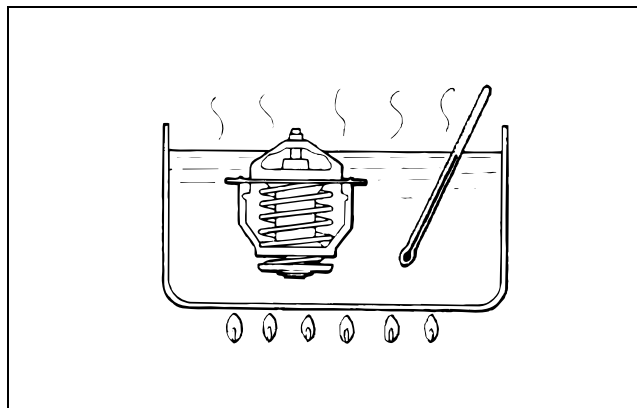


Figure 37

# Fuel System Service

## Priming Fuel System

1. Stop the engine. Unlatch and raise the hood
2. Fill the fuel tank.
3. Install a 3/16" hose over bleed screw. Put other end of hose into a container to catch fuel (Fig. 38).
4. Pump priming plunger until resistance is felt. Try to start engine. If engine does not start, go to step 5.
5. Loosen bleed screw a few turns. Pump priming plunger until a steady stream of fuel comes out of hole in bleed screw. When fuel stops foaming, tighten bleed screw during down stroke of priming plunger. Wipe up any spilled fuel.

NOTE: It may be necessary to bleed air out of the fuel line, between the fuel filter/water separator and the injection pump. To do this, loosen the fitting on the injection pump (Fig. 39) and pump priming plunger until a steady stream of fuel comes out of fitting. When fuel stops foaming, tighten the fitting during the down stroke of the priming plunger. Wipe up any spilled fuel.

NOTE: The high pressure fuel system is self-bleeding. It is not necessary to open the high pressure lines.

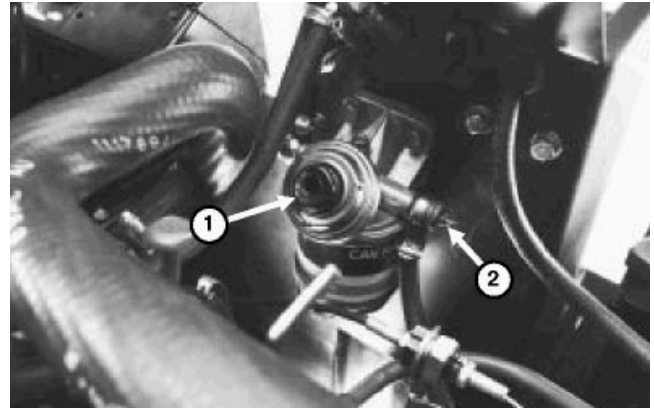


Figure 38

1. Primer plunger

2. Bleed screw

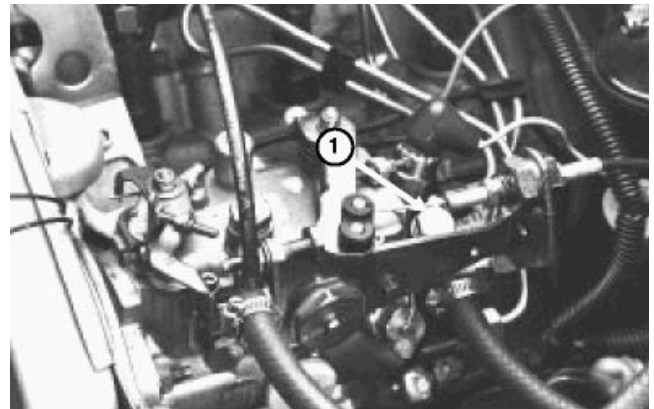


Figure 39

1. Injection pump fitting

## Injection Pump Removal

(See Injection Pump Removal in the Engine Overhaul section.)

## Injection Pump Repair

NOTE: If the pump needs to be inspected or repaired it is recommended that it be done by an authorized CAV Lucas ROTO DIESEL service dealer - especially during the warranty period. Repairs by non-authorized dealers WILL void the pump warranty.

**IMPORTANT:** Clean the injection pump and the area around the injection pump before removing or servicing it. DO NOT spray water onto a hot injection pump.

## Injector Service

NOTE: If injectors need to be inspected or repaired it is recommended that it be done by an authorized CAV Lucas ROTO DIESEL service dealer - especially during the warranty period. Repairs by non-authorized dealers WILL void the warranty on the injectors.

### Removal

1. Clean top of cylinder head and injection pipes.
2. Remove injection pipes (Fig. 57, Item 12).
3. Disconnect injector leakage pipe.
4. Remove the injectors (Fig. 58, Item 19) and retrieve the copper washer (Item 20) and flame trap washer (Item 21).

NOTE: Never disassemble injector before checking its operation.

### Disassembly and Cleaning

1. Secure the injector body in a "V" type injector holder.
2. Remove the injector holder nut.
3. Remove the injector, spacer, push rod, pressure setting spring, adjusting shims and body.
4. Dip all parts in clean diesel fuel.
5. Clean nozzle and needle in clean diesel fuel.
6. De-carbon injector nozzle using a wooden spatula. Never use metallic objects, emery cloth or rags. Do not attempt to grind the needle on its seat. Clean each injector separately to matched parts are not mixed up. The needle should slide freely and fall in the nozzle by its own weight.

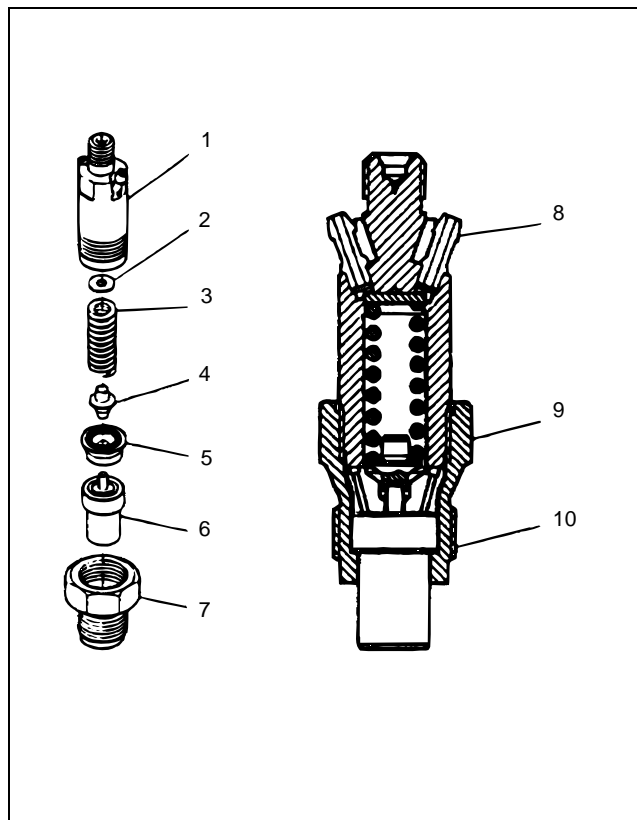


Figure 40

1. Body
2. Adjusting shim
3. Pressure setting spring
4. Push rod
5. 2-sealing face spacer
6. Injector
7. Injector nut
8. Leak return connectors
9. Injector holder nut
10. Thread

## Assembly

1. Check all parts for condition and cleanliness. Oil parts before reassembly.
2. Secure the injector body in a "V" type injector holder.
3. Install the adjusting shims, spring, push rod, spacer and injector (Fig. 40, Items 2, 3, 4, 5, 6).
4. Install the injector holder nut (Fig. 28, Item 7) and tighten by hand.
5. Tighten injector nut to a torque of 10 Nm. Tighten the nut an additional 22° of rotation.

## Installation

NOTE: Each time an injector is removed from the engine, new washers must be installed. Fire ring washer is installed with convex surface up.

1. Install new fire ring washers (Fig. 58, Item 21), convex surface facing up.
2. Install new copper washers (Fig. 58, Item 20).
3. Install the injectors and tighten to a torque of 90 Nm (66 ft-lb).
1. Install new flame arrestor steel washer and copper gasket.
2. Install injector in cylinder head.
3. Install injection pipe unions on pump and injectors and tighten by hand.
4. Moderately tighten each union, 25 Nm (18 ft-lb) max., on pump and injector. Over-tightening will distort the end of the injector line.
5. Connect fuel return pipe.

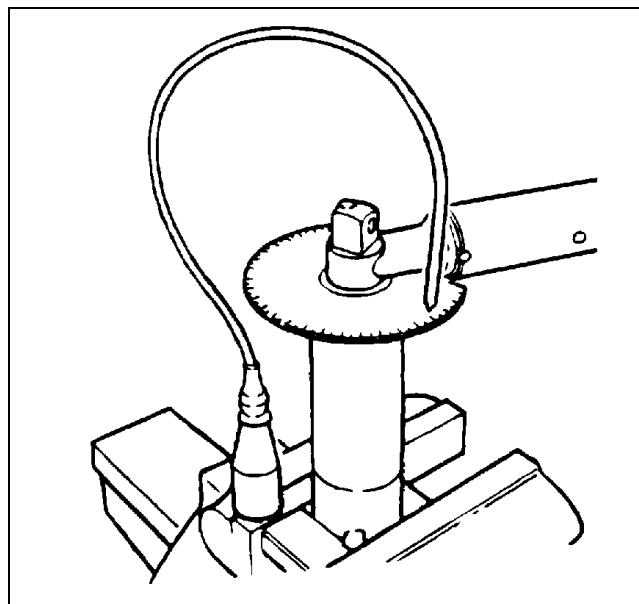


Figure 41

# Timing Belt Replacement

## Timing Belt Removal

**IMPORTANT:** Never install a used belt. When the timing belt is removed a **NEW** timing belt must be installed.

### SPECIAL TOOLS REQUIRED:

Tune-Up Tool Set TOR 4035

1 ea. M8 x 125 x 40 Metric Bolt

2 ea. M8 x 125 x 35 Metric Bolt

1. Slowly turn the crankshaft in the operating direction (clockwise as viewed from the timing belt end) until the TDC Lock Pin tool (TOR 70153N) goes into the hole in the flywheel (Fig. 42).

2. Remove the crankshaft pulley bolt (Fig. 43, Item 1) and the pulley. Note: The bolt is secured with thread locking compound and will be difficult to remove.

3. Remove cover attachment nut (Item 5), cover clips and timing belt covers (Item 2, 3 and 4) in the numbered order.

4. Re-install the crankshaft bolt (Fig. 44, Item 1) and the washer.

5. Lock the camshaft gear (Item 6) in position by installing an M8 x 125 x 40 bolt. Tighten finger tight.

6. Lock the injection pump gear (Item 7) in position with two M8 x 125 x 35 bolts. Tighten finger tight.

**IMPORTANT:** To prevent damage to the face of the injector pump housing and future timing problems, the camshaft gear and injection pump gear locking bolts must be tightened **ONLY FINGER TIGHT**.

**NOTE:** If the bolts in steps 5 and 6 cannot be installed because the holes in the gears and engine block do not align, remove the TDC Lock Pin tool and rotate the engine (clockwise) one revolution. Install the TDC Lock Pin, then install the bolts as instructed in steps 5 and 6.

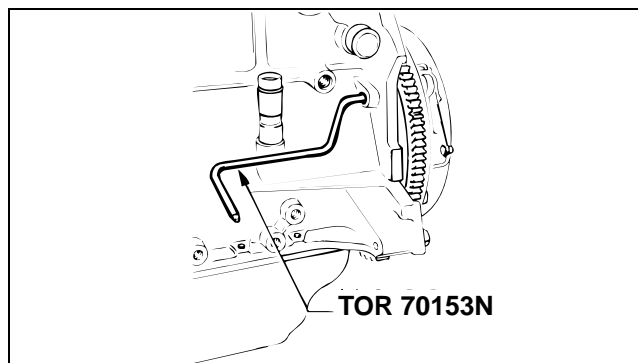


Figure 42

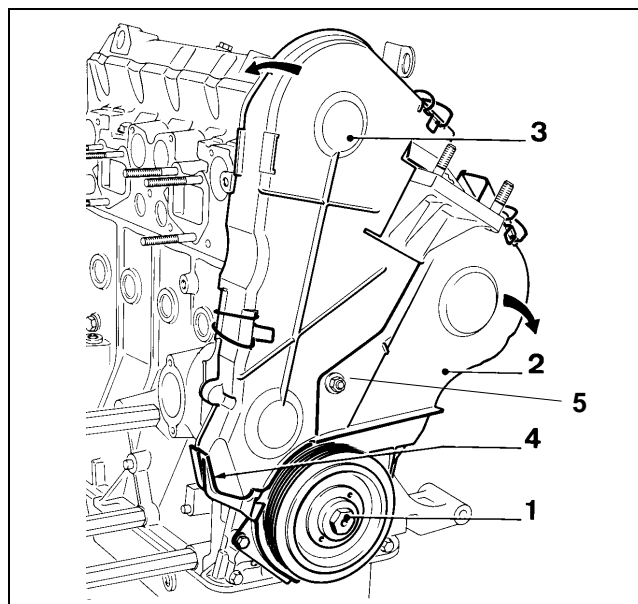


Figure 43

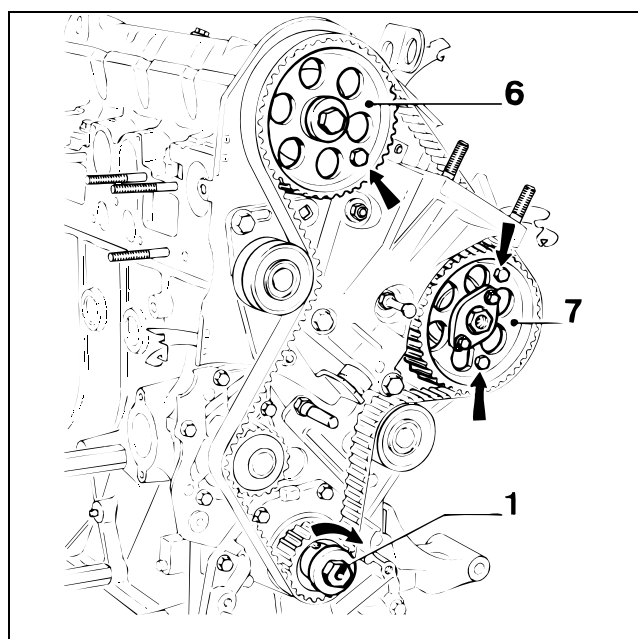


Figure 44

7. Loosen the nut (Fig. 45, Item 8) and the bolt (Item 9), securing the roller tensioner bracket (Item 10).

8. Rotate the roller tensioner bracket square (Item A) to compress the spring (Item 11).

9. Re-tighten the bolt (Item 9).

10. Remove the timing belt.

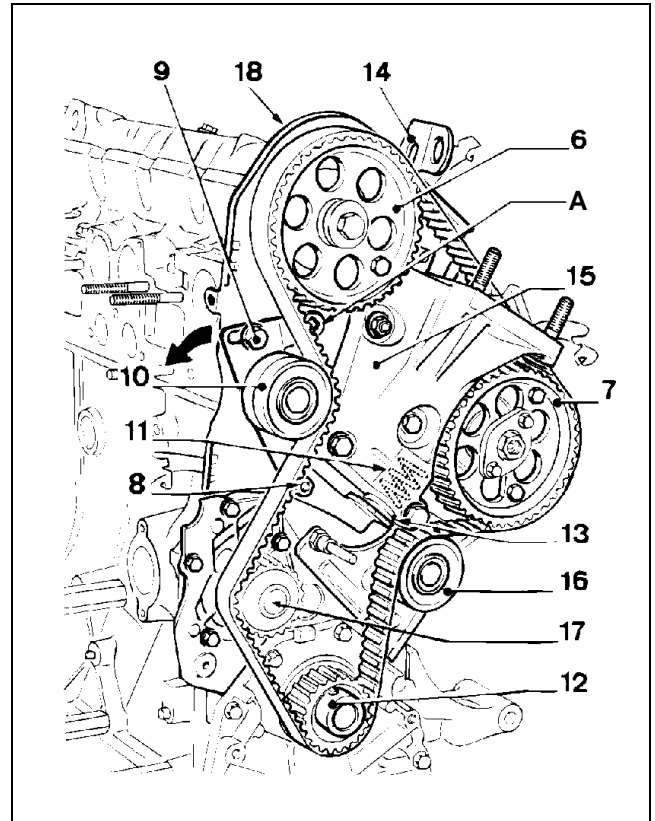


Figure 45

## Timing Belt Installation

**IMPORTANT:** Never install a used belt. When the timing belt is removed a **NEW** timing belt must be installed.

1. Install the new timing belt, with the runs taut, in the following order (Fig. 46):

- Crankshaft gear (Item 13)
- Fixed roller (Item 11)
- Injection pump gear (Item B)
- Camshaft gear (Item C)
- Tensioner roller (Item 17)
- Coolant pump gear (Item 10).

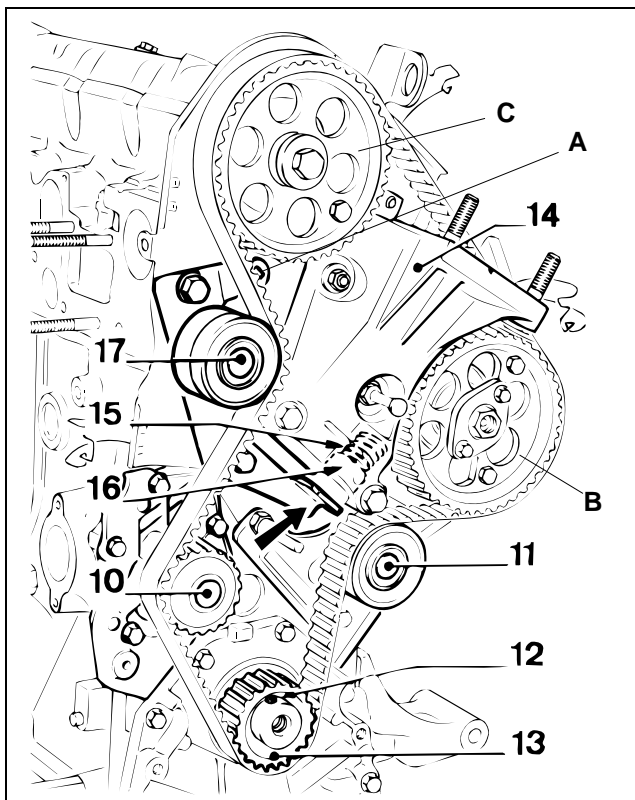


Figure 46

2. Loosen the bolt (Fig. 47, Item 18) and nut (Item 19) to release the tensioner roller. **DO NOT** use Item **A** to set tension. Tension on belt is only to be set by the spring (Fig. 46, Item 15) when tensioner plate is free to rotate.

3. Re-tighten the bolt (Item 18), then the nut (Item 19), when the belt is tensioned.

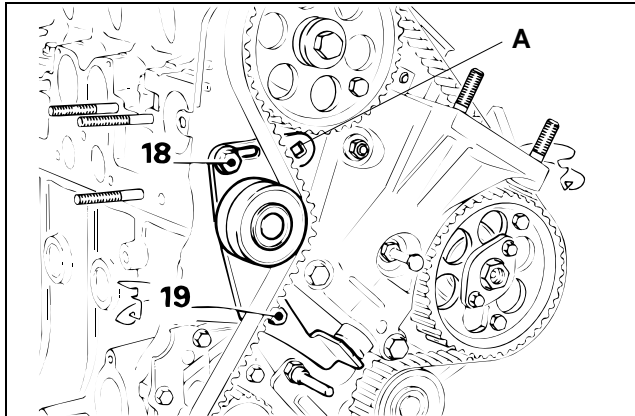


Figure 47



4. Remove the three gear locking bolts and TDC Lock Pin tool.
5. Turn the crankshaft two revolutions (clockwise).
6. Re-install the TDC Lock Pin tool TOR 70153 N and the three gear locking bolts.

**IMPORTANT: If you can not install any one of the locking devices, repeat the Timing Belt Installation procedures from the beginning.**

7. Loosen the bolt (Fig. 48, Item 18) and nut (Item 19) to release the tensioner roller.
8. Re-tighten the bolt (Item 18) then the nut (Item 19) to a torque of 17.5 Nm (13 ft-lb).
9. Remove the three gear locking bolts.

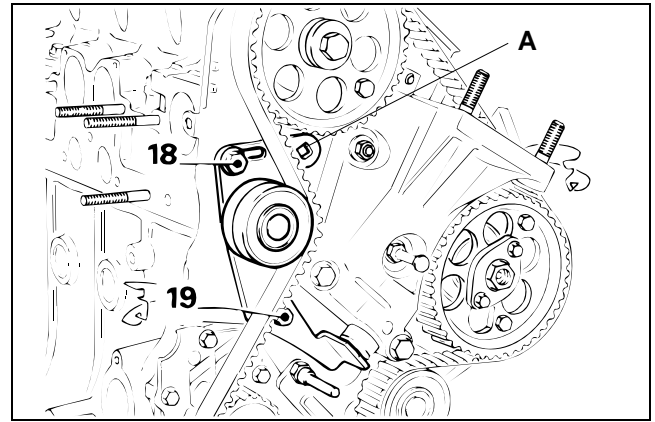


Figure 48

10. Install the covers (Fig. 49, Item 2, 3 and 4), cover clips and cover attachment nut (Item 5).

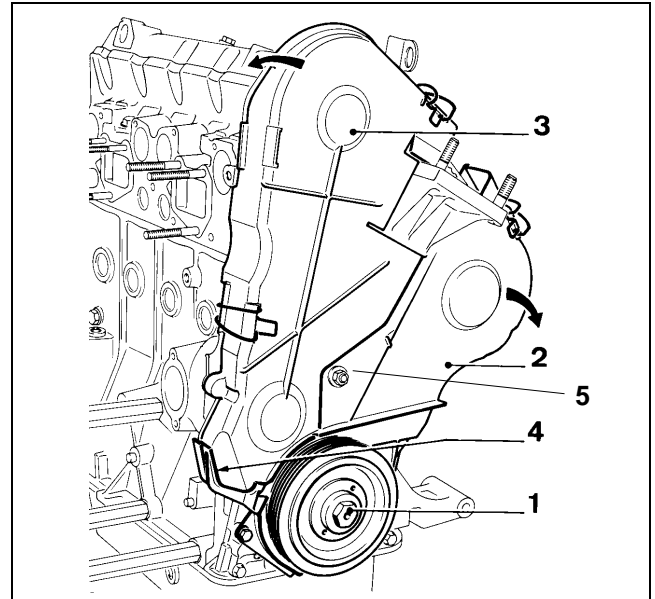


Figure 49

11. Install the pulley.

A. Clean with a brush and de-grease the threads of the bolt (Fig. 50, Item 1), the bearing faces of the washer (Item 2) and the head of the bolt (Item 1).

B. Coat the threads of the bolt (Item 1) with thread lock LOCTITE. Install the bolt (Item 1) and washer (Item 2) and tighten to a torque of 40 Nm (30 ft-lb).

C. Tighten the bolt 60° further (one flat).

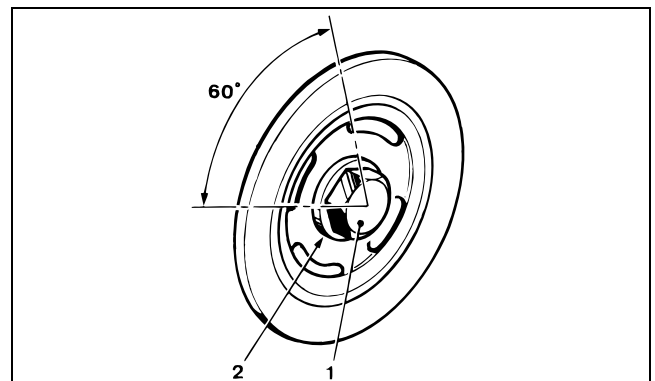


Figure 50

# Injection Pump Timing

## Timing of Injection Pump (Pump Mounted on Engine)

The adjustment position for start of injection varies on each pump (manufacturing tolerances). The adjustment position is given by measurement "X.XX" in one of three places on the pump (Fig. 51):

- a. Tag on pump lever.
- b. Bar code label
- c. Inspection cap

NOTE: "PMH" in French = "TDC" in English.

1. Remove the cover attachment nut, cover clips and timing belt covers.

2. Slowly turn the crankshaft in the operating direction (clockwise as viewed from the timing belt end) until the TDC Lock Pin tool (TOR 70153N) goes into the hole in the flywheel (Fig. 52).

3. Verify that the camshaft and injection pump gears are properly timed:

A. Lock the camshaft gear (Fig. 53, Item 6) in position with a M8 x 125 x 40 bolt. Tighten finger tight.

B. Lock the injection pump gear (Item 7) in position with two M8 x 125 x 35 bolts. Tighten finger tight.

NOTE: If the locking bolts cannot be installed because the holes in the gears and engine block do not align, remove the TDC Lock Pin tool and rotate the engine (clockwise) one revolution. Install the TDC Lock Pin, then install the bolts as instructed.

**IMPORTANT: To prevent damage to the face of the injector pump housing and future timing problems, the camshaft gear and injection pump gear locking bolts must be tightened ONLY FINGER TIGHT.**

4. Remove the three locking bolts (Fig. 53).

5. Remove the TDC Lock Pin tool TOR 70153N, then turn the crankshaft 1/4 to 1/3 turn in the opposite direction of running (counterclockwise as viewed from the timing belt end).

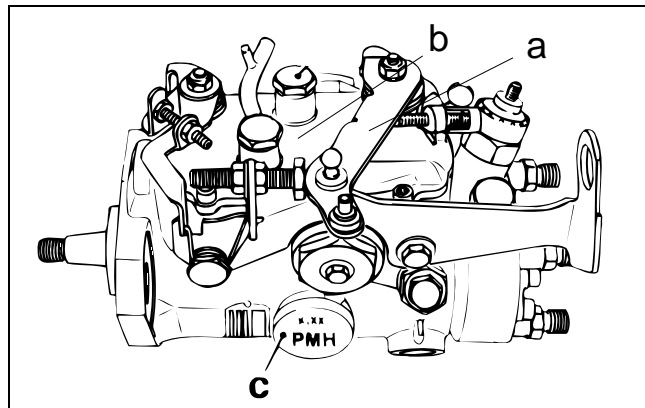


Figure 51

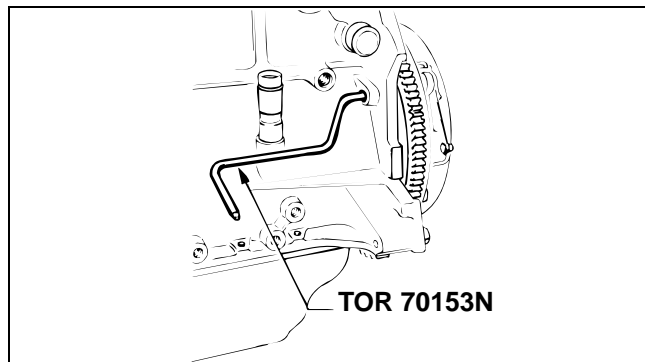


Figure 52

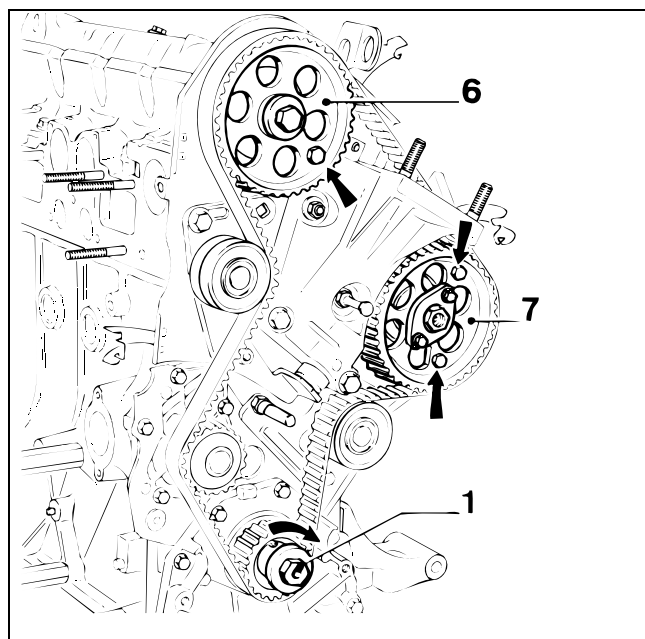


Figure 53

6. Clean the area around the pump timing plug (Fig. 54, Item d). Remove the pump timing plug.

7. Use Timing Tool Assembly TOR 80117 AM. Lubricate the timing rod (Fig. 55, Item 1) with Diesel fuel, then install the timing rod in the pump timing hole (Item d). Check to see that the rod moves freely in the bore.

8. Install the dial indicator (metric) on the indicator bracket (Item 2).

9. Install the indicator bracket with dial indicator on the plug boss. Set the dial indicator to "0.00 mm".

10. Slowly turn the crankshaft in the operating direction (clockwise as viewed from the timing belt end) until the TDC Lock Pin tool (TOR 70153N) goes into the hole in the flywheel (Fig. 56).

11. The dial indicator should show the reading "X.XX"  $\pm 0.04$  mm engraved on the injection pump. If adjustment is required, loosen the three bolts at the pump flange, one bolt at the rear, and the injection lines. Rotate the pump away from the engine, then slowly rotate the pump toward the engine in one smooth motion to obtain the reading "X.XX". If you go too far and the reading is passed, stop. Again, rotate the pump away from the engine, then rotate the pump toward the engine in one smooth motion.

12. After obtaining the correct reading, be careful to keep the pump in position and tighten the pump bolts.

13. Remove the TDC Lock Pin tool TOR 70153 N.

14. Turn the crankshaft 1/4 to 1/3 turn in the opposite direction of running (counterclockwise as viewed from timing belt end). Check that the indicator reads 0.00.

15. Slowly turn the crankshaft in the operating direction (clockwise as viewed from the timing belt end) until the TDC Lock Pin tool (TOR 70153N) goes into the hole in the flywheel (Fig. 56).

16. In this position the dial indicator mounted on the pump should read the value "X.XX" shown on the pump  $\pm 0.04$  mm.

17. Check to make sure the three lock bolts fit in the cam pulley and injection pump pulley (Fig. 53).

18. Repeat steps 11 and 12 if necessary.

19. Remove TDC Lock Pin tool, three lock bolts, indicator and indicator bracket. Install pump cover plug.

20. Tighten injector lines.

21. Install timing belt covers, clips and attachment nut.

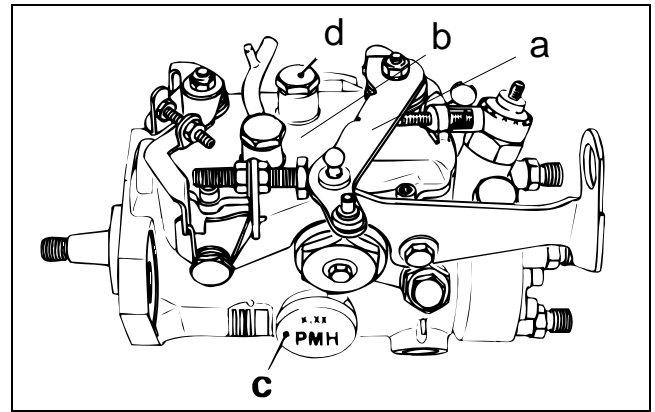


Figure 54

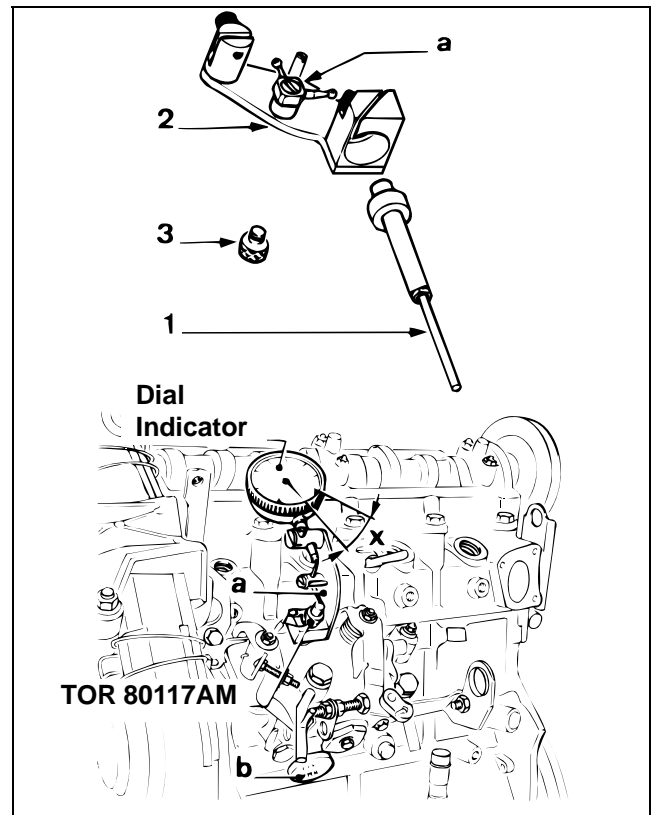


Figure 55

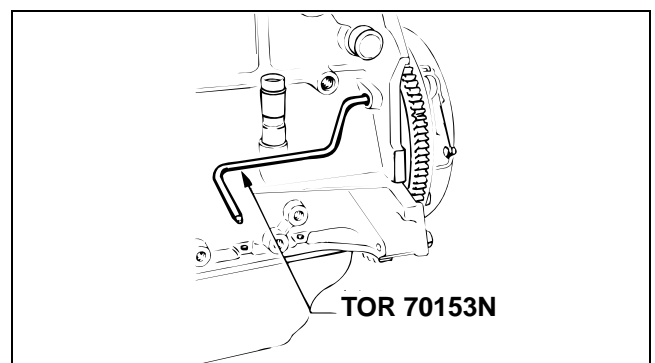


Figure 56

# Preparation For Engine Repair

1. Before cleaning and disassembly, carefully check for problems that cannot be found after the engine has been cleaned or disassembled (e.g. oil leaks from cracked components, gaskets or loose fittings, damaged air cleaner or breather hoses that could cause cylinder wear, etc.). Make a note of any problems that you find.

2. Clean or wash the engine exterior thoroughly before disassembly.

**IMPORTANT: Do not spray water on a hot engine. Injection pump seizure or other failures could result.**

3. Do not disassemble or remove parts that do not require disassembly.

4. Disassemble the engine in proper order, arranging the parts the disassembled parts neatly. Apply clean engine oil to all disassembled parts to prevent rust.

5. Keep the work area clean; dirt causes engine failures.

6. Be very careful when working on fuel system components. Cover the work area with clean paper. Store components of the nozzles or injector pump in clean fuel oil. Do not allow components to strike each other or other objects. Wet hands with clean diesel fuel before handling these parts.

**IMPORTANT: Apply clean engine oil to all surfaces when engine is assembled to prevent marking when engine is first started.**

---

## Cylinder and Cylinder Block Overhaul

Before removing any parts, disassembly or overhaul of the Peugeot engine, it is very important to understand the nature and probable cause of the problem that made an overhaul necessary.

When the engine trouble is caused by worn cylinders, rings or valves, one or more of the following symptoms will occur:

1. Low engine power, and a decrease in compression pressure.
2. Increased fuel consumption.
3. Increased lubricating oil consumption.
4. Poor engine starting.
5. Loud noises in the engine.

It is important to find the cause of the engine failure before beginning repair. Symptoms 2 and 4 in the above

list can be a result of excessive fuel injection, improper injection timing, or nozzle and injection pump wear. Poor starting may be a result of electrical problems. Noises may be associated with a mechanical part outside the engine. Excess fuel or oil consumption may be the result of leaks. (See the Troubleshooting section.)

Another indicator of the need for an overhaul is oil consumption. Make sure the engine does not leak oil. When the oil consumption between the oil change maintenance interval is approximately 1-1/2 times normal (150%), engine overhaul should be considered.

With a good knowledge of how the engine operates, access to maintenance and compression test records, and information in the Troubleshooting section of this chapter, unnecessary disassembly and inspection can be eliminated.

# Engine Removal and Installation

1. Put machine on a level surface and engage parking brake. Turn engine OFF and remove key from ignition switch. Allow engine and radiator to cool.

2. Open the hood. Disconnect hood stop cable from engine. Lower the hood. Remove left and right hinge plates. Lift hood off chassis.

3. Disconnect positive (+) and negative (–) battery cables from battery. Loosen battery securing bolt and remove battery.

4. Open the radiator cap. Open radiator drain valve or remove lower radiator hose and allow coolant to drain into a pan.



## CAUTION

**DO NOT open radiator cap or drain coolant if engine or radiator is hot. Pressurized, hot coolant can escape and cause burns.**

5. Loosen hose clamps and disconnect upper and lower radiator hoses from engine and radiator.

6. Loosen hose clamp and remove fuel hose from injector pump. Plug end of fuel line to prevent fuel leakage. Disconnect injector return hose.

7. Loosen hose clamp and disconnect PCV hose from engine.

8. Disconnect and tag electrical wires that attach to the engine or engine components: alternator, starter motor and solenoid, ground cable, oil pressure switch, temperature gauge sender, thermostatic switch, fuel stop (ETR) solenoid, glow plugs.

9. Disconnect drive coupling from flywheel end of engine.

10. Remove upper fan shroud from radiator.

11. Disconnect throttle cable from speed control lever on fuel injection pump. Loosen clamp and remove throttle cable and from engine bracket.

12. Remove fasteners securing engine to engine mounts.

13. Attach a short section of chain between the two lifting brackets on the engine. Connect hoist, or block and tackle chain at center of the short section of chain. One person should operate hoist or block and tackle and other person should help guide engine out of chassis. Remove engine from chassis. Be careful when removing engine to prevent damage to engine, radiator or other parts. Mount engine in an engine rebuilding stand.

14. Remove muffler, brackets, coolant expansion tank and accessories from engine as necessary. Drain oil from engine and remove engine oil filter.

---

## Installing the Engine

1. To install the engine, perform steps 2- 14 of Removing the Engine in reverse order.

2. After disassembling or overhauling the engine, install a new oil filter. Replace this filter after the first 20 to 50 hours of operation.

3. Fill the engine with the correct oil. Fill the cooling system with a 50/50 solution of ethylene glycol anti-freeze, and clean, soft water. Check for oil and coolant leaks and repair as necessary.

Peugeot recommended Coolant/Antifreeze is available in 1 U.S. Gallon containers under Toro Part No. 93-7213.

**IMPORTANT: The anti-freeze should contain no Borate and have a Ph of 7 to 8.5.**

4. Adjust the throttle linkage.

# Engine Overhaul

## Disassembly of External Components

1. Remove TDC sensor and clutch housing centering pin.
2. Mount the engine on a stand.
3. Lock the flywheel with TOR FD86 tool.
4. Remove exhaust manifold and inlet manifold.
5. Remove the coolant manifold.
6. Remove the alternator and belt.
7. Remove the oil filter (Fig. 57, Item 10).
8. Remove the injector pipes (Item 12).
9. Remove the glow plug leads.
10. Remove the crankcase breather pipes/oil filter/filter pipe assembly (Item 13).
11. Remove the oil pressure switch (Item 14).

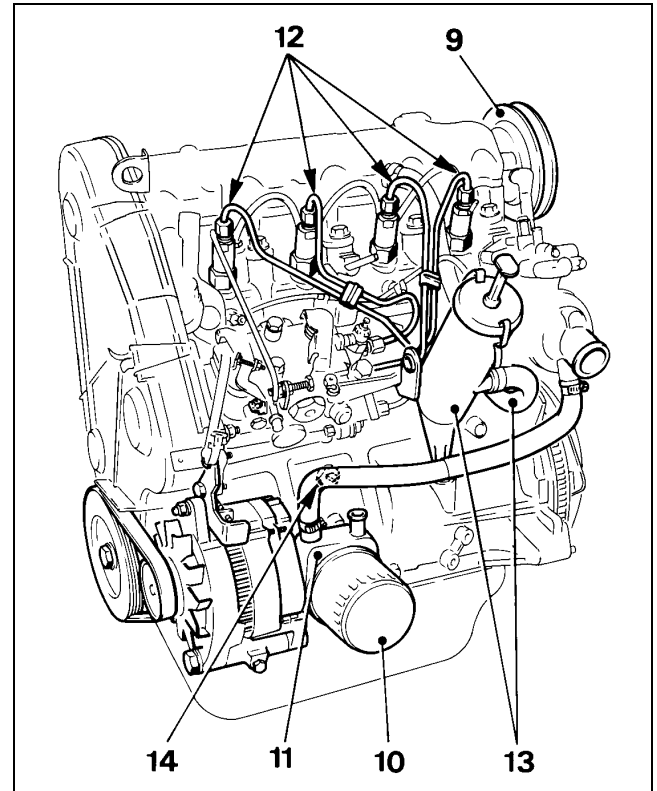


Figure 57

12. Remove the thermostat housing cover (Fig. 58, Item 17).

13. Remove the thermostat housing (Item 18).

14. Remove the injectors (Item 19) and retrieve the copper washer (Item 20), and flame trap washer (Item 21).

15. Remove the glow plugs (Item 22).

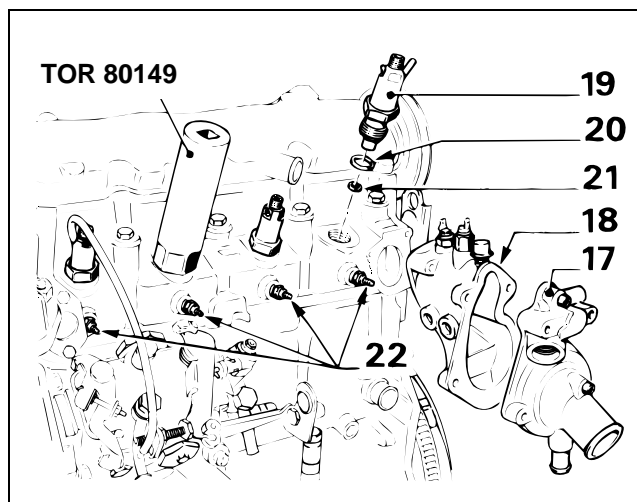


Figure 58

## Injection Pump Removal

1. Remove the timing belt.

2. Use injector pump gear puller TOR70153H, to remove injector pump gear (Fig. 58a, Item 5).

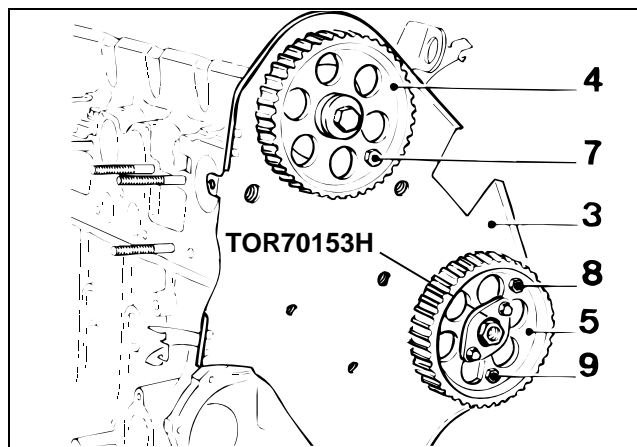


Figure 58a

3. Remove the injection pump (Fig. 58b, Item 19).

4. Remove bracket (Item 20).

**NOTE:** If the pump needs to be inspected or repaired it is recommended that it be done by an authorized CAV Lucas ROTO DIESEL service dealer - especially during the warranty period. Repairs by non-authorized dealers WILL void the pump warranty.

**IMPORTANT:** Clean the injection pump and the area around the injection pump before removing or servicing it. DO NOT spray water onto a hot injection pump.

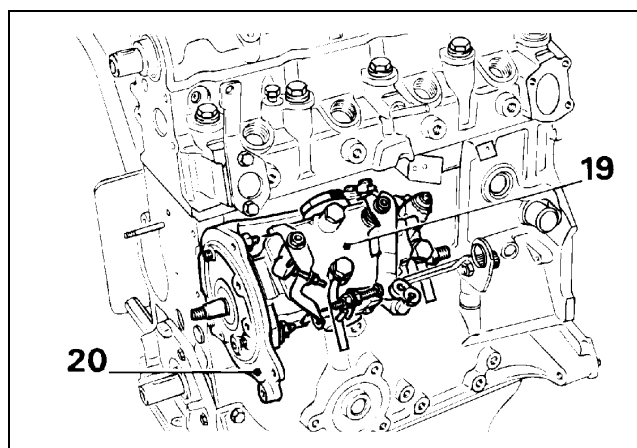


Figure 58b



## Cylinder Head Removal

1. Remove the cylinder head cover.
2. Use a Torx head T55 tool to loosen the cylinder head bolts, working in a spiral from the outside. Remove the cylinder head bolts.

**IMPORTANT: DO NOT pry at gasket surface to loosen cylinder head from block.**

3. Use levers (0.0149) to release the cylinder head from the block.
4. Remove the cylinder head and gasket.

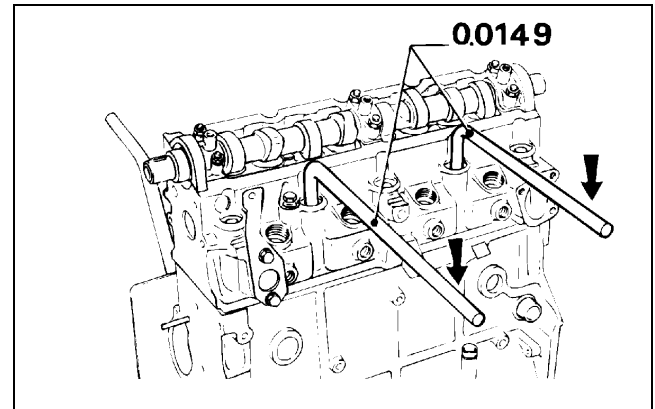


Figure 59

## Oil Pump Removal

1. Remove the oil pan and gasket

**IMPORTANT: Use solvent and a wood or plastic scraper to remove the silicone gasket material. Be careful not to damage the sealing face of the block.**

2. Remove the bolts (Fig. 60, Item 1, 2, and 3).
3. Remove the seal carrier plate (Item 4).

**IMPORTANT: The bolt (Item 1) is a special bolt that centers the pump in the correct location.**

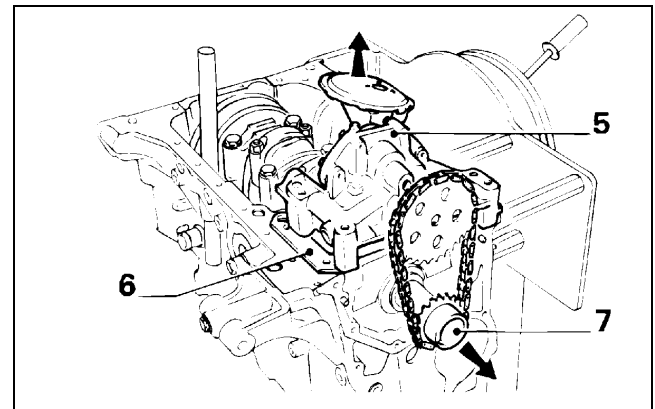


Figure 60

4. Remove the pump (Fig. 61, Item 5) / drive chain / crankshaft sprocket (Item 7) assembly. NOTE: Item 6 - spacer is not used on engines used in TORO machines.

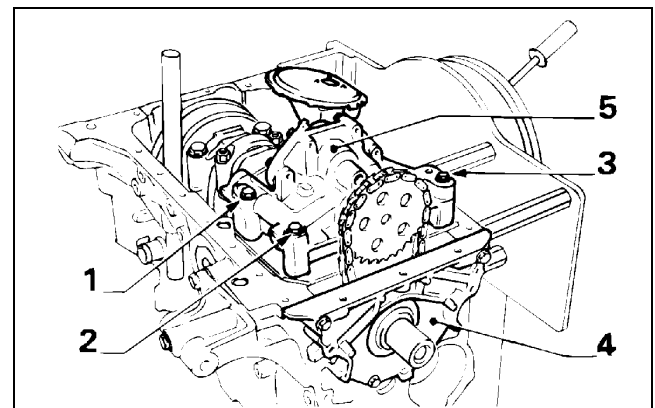


Figure 61

## Crankshaft and Piston Removal

1. Remove flywheel locking tool.
2. Remove the connecting rod end caps (Fig. 62, Item 8), marking each cap for re-installation in the same location.

NOTE: Connecting rods and end caps are not numbered. Once they are removed there is no way of knowing the correct location for installation unless you mark them for re-installation.

3. Remove the flywheel.
4. Remove the main bearing caps (Item 9) (marks are cast-in).

5. Retrieve end float washers with No. 2 cap.

5. Remove the oil seal (Fig. 63, Item 10).

6. Remove the end float washers (Item 11).

7. Remove the crankshaft.

8. Remove the main bearing shells.

9. Remove the piston/connecting rod assemblies, marking each piston and connecting rod for re-installation in the same location.

NOTE: Connecting rods and end caps are not numbered. Once they are removed there is no way of knowing the correct location for installation unless you mark them for re-installation.

10. Remove the piston pin circlips and separate the pistons from the connecting rods.

11. Remove the plugs (Fig. 63 and 64, Item 12) from the oil galleries.

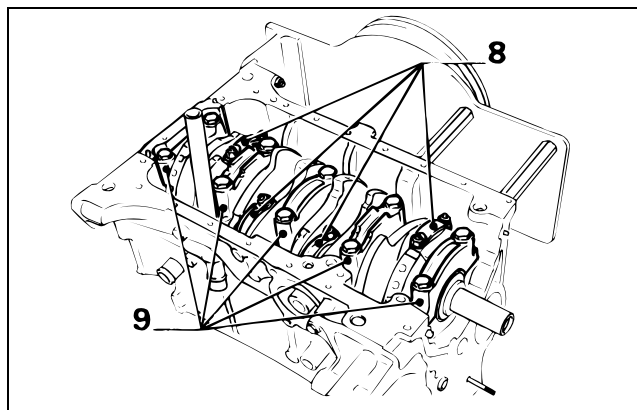


Figure 62

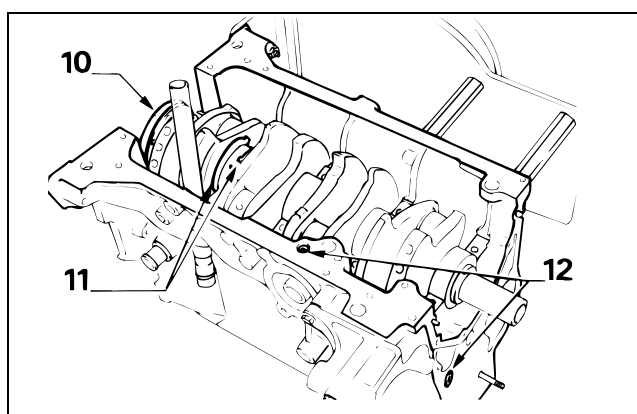


Figure 63

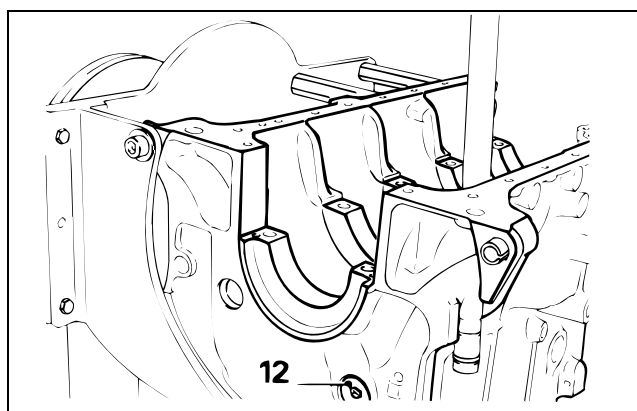


Figure 64

## Cylinder Head Overhaul

1. Progressively slacken the camshaft bearing caps (Fig. 65, Item 1).

2. Remove the bearing caps (Item 1), oil seals (Item 2), camshaft (Item 3), tappets (Item 4) and adjustment shims (Item 5). Mark adjustment shims and tappets so they will be re-installed in the same location – #1 intake, #1 exhaust, #2 intake, #2 exhaust, etc.

NOTE: The shims are small and can stick to the tappets.

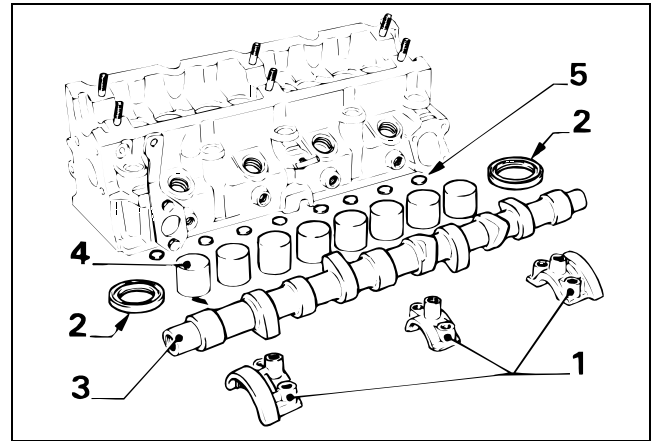


Figure 65

3. Use a valve compressor to remove the eight valves (Fig. 66).

4. Use a hammer and drift to remove the swirl chambers from the injector orifices, if necessary.

NOTE: Swirl chambers do not need to be removed unless cylinder head is to be machined or replaced.

5. Clean the cylinder head. Use a wooden scraper and gasket stripping solvent to clean the gasket face. DO NOT use a metal scraper.

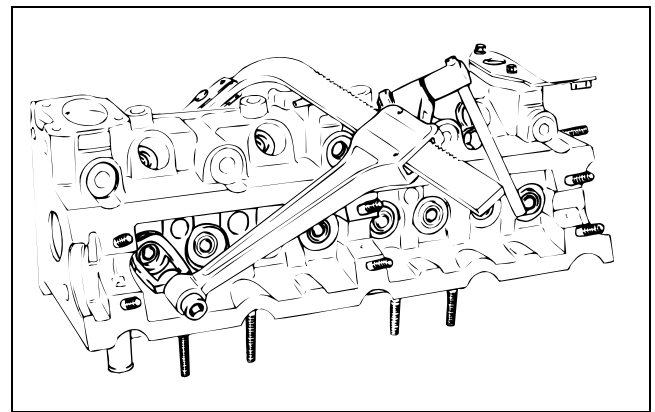


Figure 66

6. Check the gasket face for bow (flatness). Check corner to corner and side to side (Fig. 67).

Maximum bow: 0.7 mm.

7. Check the condition of the valve seats and guides, valve, valve springs, swirl chambers, camshaft, camshaft bearings and all tapped holes. (See Identification and Specifications section.)

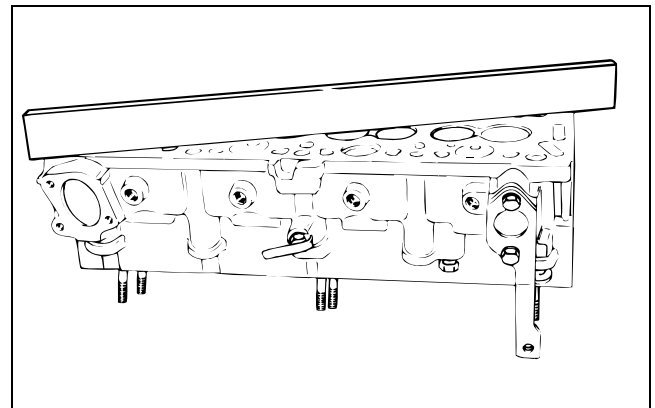


Figure 67

8. Check the protrusion of the swirl chambers (Fig. 68, A).

Protrusion: 0 to 0.03 mm

Achieve this dimension by machining faces (a) and (b).

9. Check the valve recess (B).

Exhaust: 0.9 to 1.45 mm

Inlet: 0.5 to 1.05 mm

Achieve this dimension by machining the valve seats.

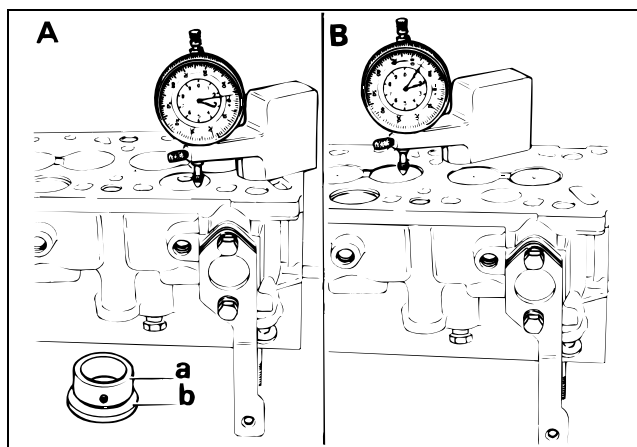


Figure 68

10. Lap in the valves.

11. Re-install the valves.

**IMPORTANT: If the cylinder head has been machined, fit compensating washers under the valve springs. (See Identification and Specifications section.)**

12. Install the shims as removed in step 2. If replacing cylinder head or if cylinder head has been machined, install a basic shim (Fig. 69, Item 6) (2.425 mm thick) to each valve stem and check that each shim is higher than the spring cup (Item c). If a shim is not higher than the cup, grind the top of the cup (Item c).

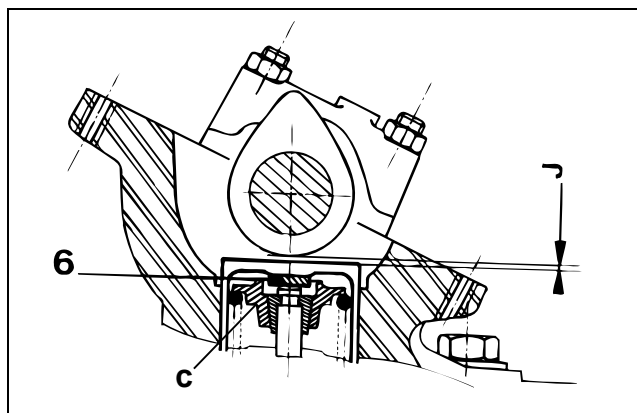


Figure 69

13. Re-install the tappets.

14. Oil the camshaft bearings.

15. Install the camshaft, with the **DIST** mark at the timing gear end.

16. Progressively tighten the bearing caps to a torque of 17.5 Nm (13 ft-lb). The bearing caps have cast-in markings for correct installation.

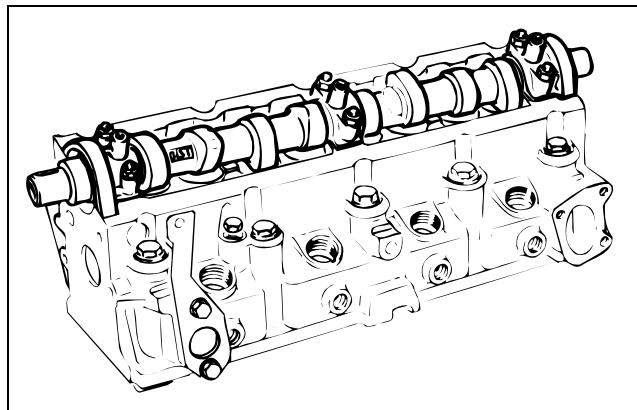


Figure 70

## Crankshaft Installation

1. Put thread lock Loctite on the oil gallery plugs and install them in the cylinder block.

2. Install the grooved main bearing shells. (See Crankshaft in the Inspection and Specifications section for main bearing shell thickness.)

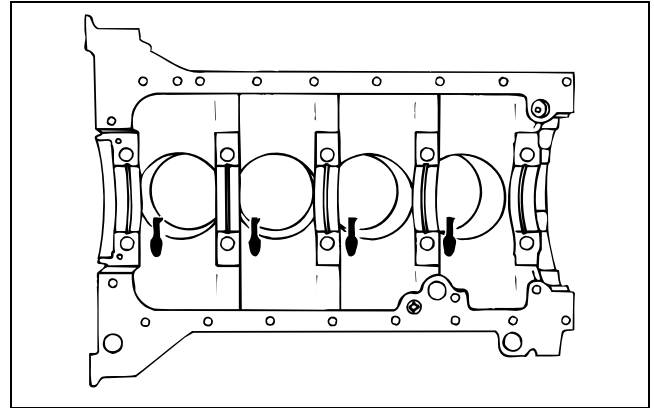


Figure 71

3. Install the crankshaft.

4. Install the no. 3, 4 and 5 main bearing caps.

5. Install the two end float half-washers (Fig. 72, Item 1), with the anti-friction faces towards the crankshaft.

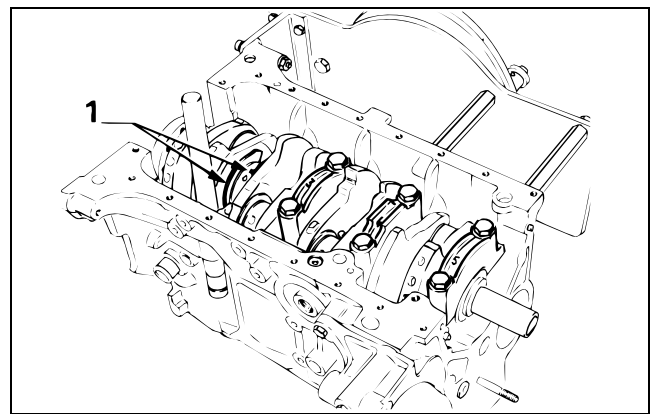


Figure 72

6. Install the no. 2 main bearing cap (Fig. 73, Item 2) with its two end float half-washers, with the anti-friction faces towards the crankshaft.

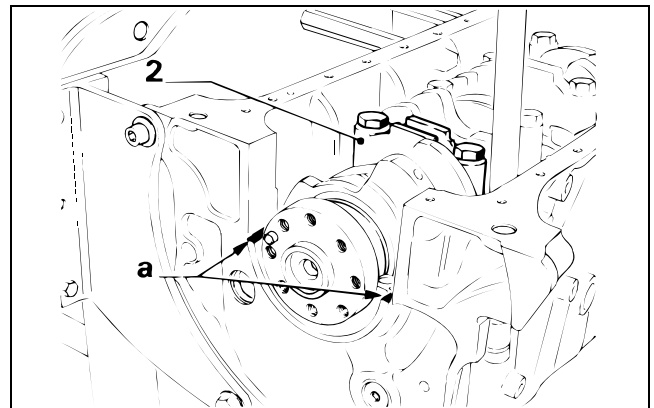


Figure 73

7. Check crankshaft end float (Fig. 74):

A. Install the dial indicator, using tools TOR 80110G1, TOR 80504 A1 and A2.

B. End float must be between 0.07 and 0.32 mm.

NOTE: For choice of half-washer thickness see Crankshaft in the Identification and Specifications section.

8. Apply a thin coat of Formetanch or Permatex No. 2 sealant to surface of block where bearing cap will mate (Fig. 73, Item a).

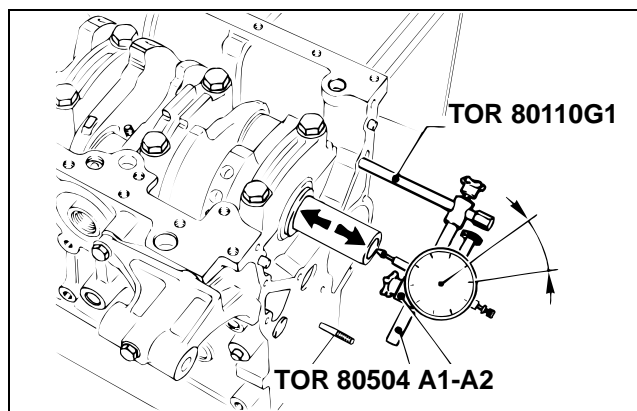


Figure 74

9. Install the two new side seals (Fig. 75, Item 3) to no. 1 main bearing cap.

10. Using a bolt and washer (Item 5), attach tool 80153 fitted with shims A2 to no. 1 main bearing cap (Item 4).

11. Adjust the height (x) of the shims.

x = 0.5 mm above flat on side of rear main cap

12. Oil the shims and the housing.

**IMPORTANT: To avoid stretching the side seals, fit the cap as follows:**

A. Engage it in its housing at 45°.

B. Straighten it.

C. Lower it slowly.

D. Tighten the two bearing cap bolts (Item 6) finger tight.

E. Remove the capscrew securing the tool to the main bearing cap and withdraw the tool horizontally.

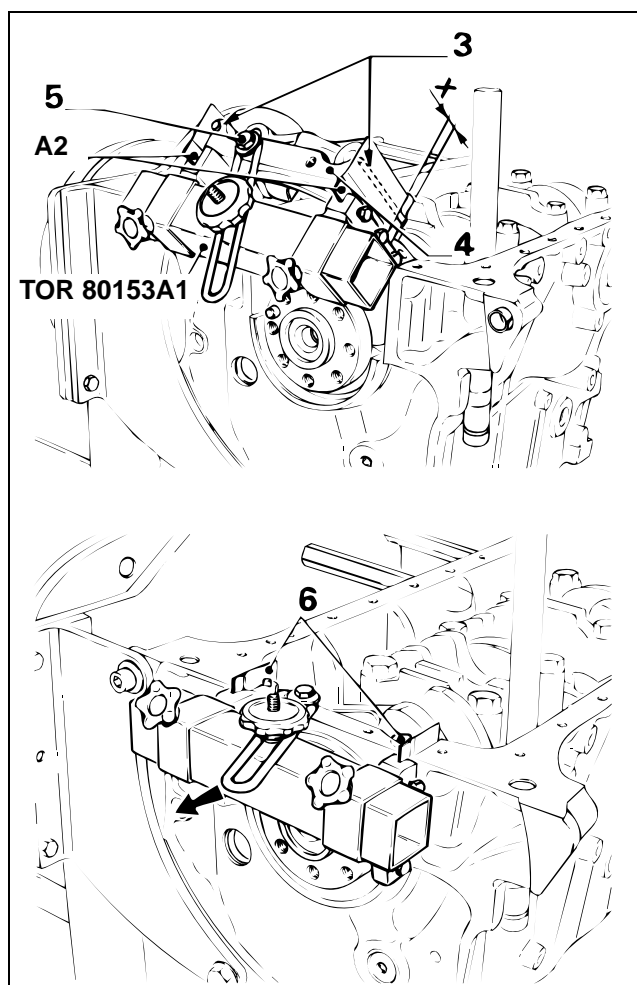


Figure 75

13. Tighten the bearing cap bolts to a torque of 70 Nm (52 ft-lb).

14. Using shim TOR 80110DZ, cut off the side seals so that they protrude 2 mm.

15. Check that the crankshaft rotates without tight spots.

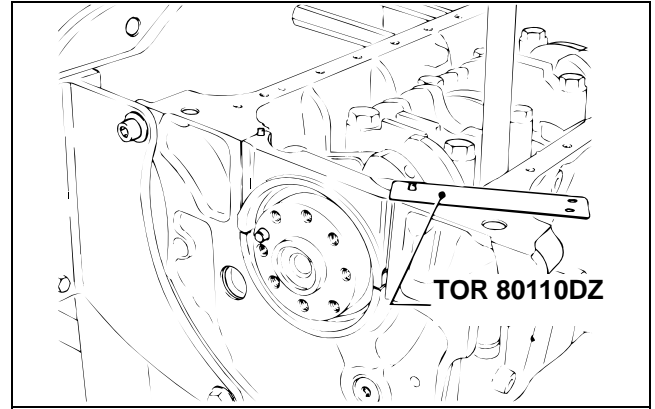


Figure 76

## Pistons and Connecting Rod Assembly

1. Assemble the connecting rods and pistons with the bearing shell tab recess (Fig. 77, Item a) on the same side as the piston crown recess (Item b).

2. Use a piston rings pliers to install the piston rings:

NOTE: The marked face of the tapered ring must be towards the combustion chamber.

- (1) – scraper ring
- (2) – tapered ring
- (3) – domed chrome ring

Space the ring gaps at 120° in relation to the scraper ring gap (Item c).

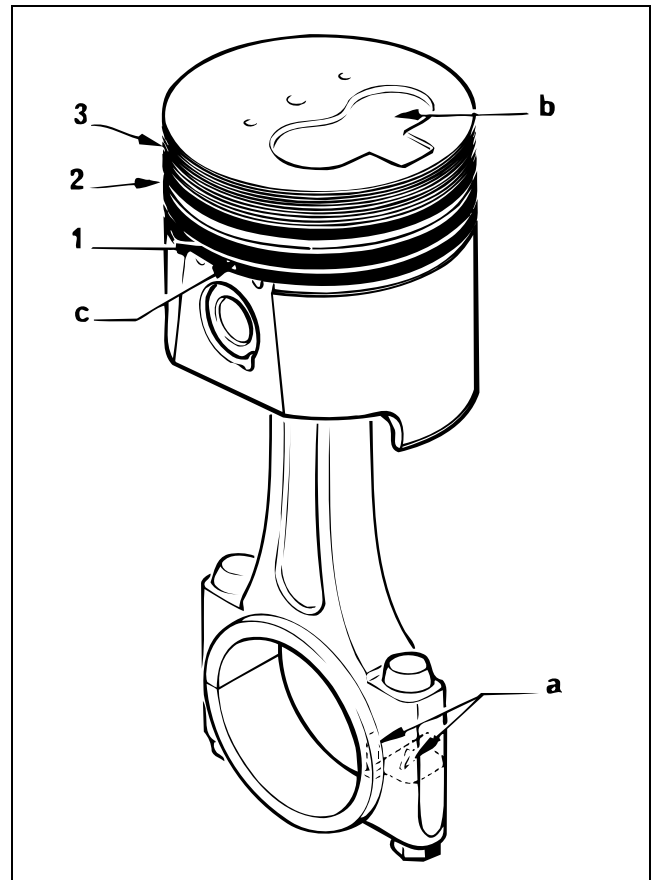


Figure 77

3. Oil the piston and tighten the piston ring clamp (Fig. 78, Item 4).

4. Remove the connecting rod end caps.

5. Install the pistons in the bores, matching the markings made when removed, and aligning the crown recess (Item a) on the oil filter side of the block.

6. Install the connecting rod end caps. Tighten the nuts to a torque of 50 Nm (37 ft-lb).

NOTE: For choice of bearing shell thickness, see Crankcase in Identification and Specifications section.

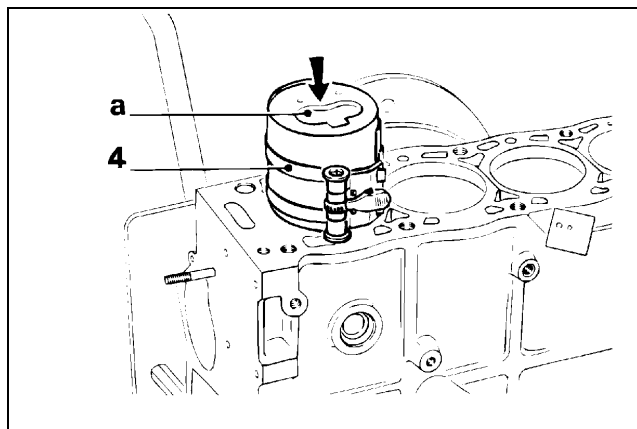


Figure 78

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## Oil Seal Installation

1. Put a new oil seal on tool TOR 70153 C.

2. Install seal with lip toward the inside of the engine block to keep the oil in. Fit the seal by tapping fully home with a mallet.

3. Withdraw the tool with a twisting movement.

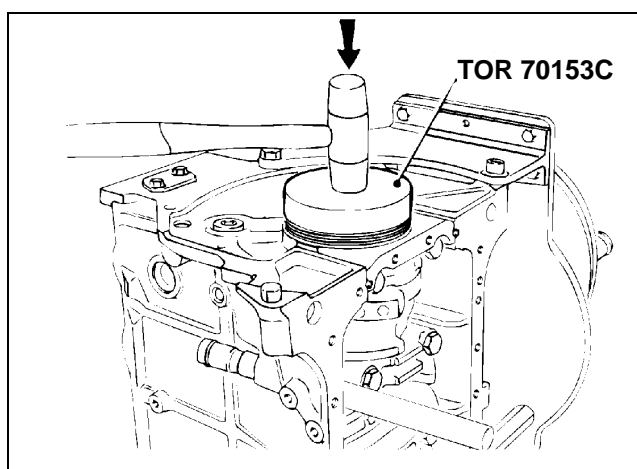


Figure 79

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## Oil Pump Installation

1. Install the key (Fig. 80, Item 6).

2. Install the pump (Item 7), drive chain and sprocket (Item 8) assembly.

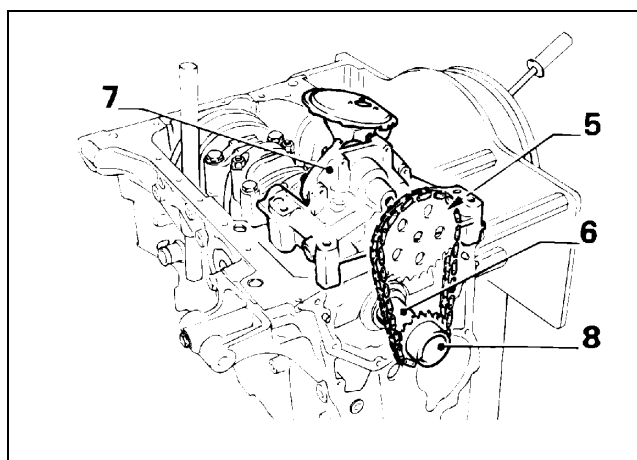


Figure 80



3. Install the special shoulder bolt (Fig. 81, Item 1) to center the pump in the proper location.
4. Install the other bolts and tighten the bolts (Item 1, 2, 3) to a torque of 20 Nm (15 ft-lb).
5. Install the seal carrier plate and a new gasket (Item 4) and tighten the bolts to a torque of 15 Nm (11 ft-lb).
6. Put a new oil seal on tool TOR 70153 D.
7. Install the seal by tapping it fully home with a mallet.
8. Apply Formetanch or Permatex No. 2 sealant as shown (Item a).
9. Install oil pan gasket:

**XUD9A Engine:** Install the oil pan gasket.

**XUD9AI Engine:** Apply silicone sealant to the oil pan using the pattern shown in Figure 81a. Wait 10 minutes before installing the oil pan to allow partial hardening of the gasket material.

10. Install the oil pan (Item 5).
11. Install the bolts (Item b).

**NOTE:** The two shorter bolts are installed into the main bearing cap.

12. Tighten the bolts (Item b) to a torque of 20 Nm (15 ft-lb).

13. Wait a minimum of 1 hour for the oil pan gasket to harden before filling with oil.

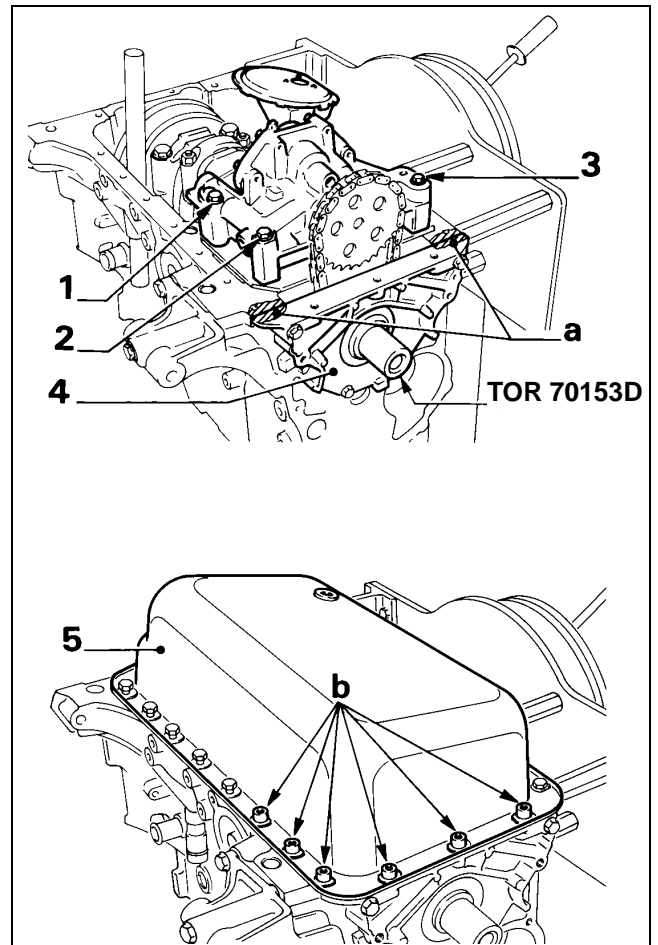


Figure 81

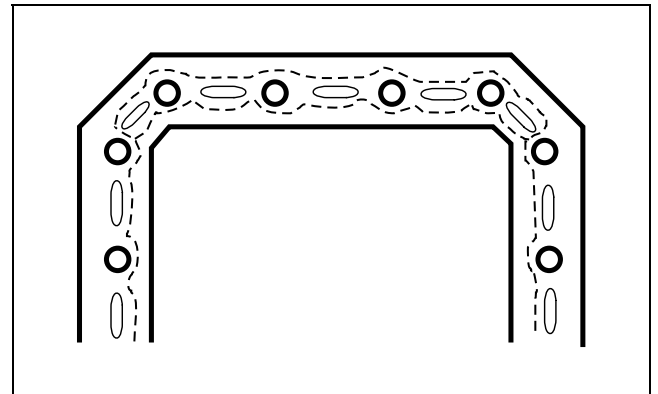


Figure 81a

## Flywheel Installation

1. Install the flywheel. Put Locket thread lock on the flywheel mounting bolts.
2. Install a TORFD86 flywheel locking tool.
3. Tighten the flywheel bolts to a torque of 50 Nm (37 ft-lb).
4. Remove the flywheel locking tool.

## Cylinder Head Gasket Selection

1. Install the dial indicator on support TOR 80110 H and zero it on a surface plate.
2. Turn the crankshaft and measure the protrusion of each piston at TDC.
3. Note the maximum protrusion (Fig. 82, Item d).
4. Select a cylinder head gasket of suitable thickness.

Units: mm

Piston protrusion (d)	Thickness identification
0.56 to 0.71	2 notches
0.71 to 0.75	3 notches
0.75 to 0.79	4 notches
0.79 to 0.83	5 notches

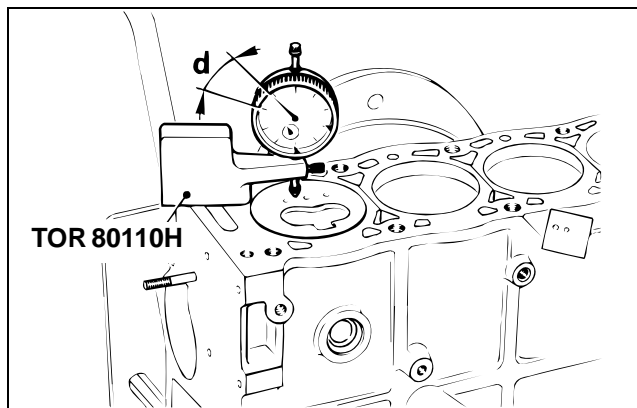


Figure 82

## Cylinder Head Installation

1. Turn the crankshaft to put the pistons at mid-stroke with damper pulley key (Fig. 83, Item 6) at the 9 o'clock position.
2. Clean the tapped holes in the cylinder block (12 x 150 thread).
3. Install the centralizing dowel (Item 7).
4. Install a new head gasket (dry).
5. Install the cylinder head.
6. Carefully clean the threads of the cylinder head bolts with a brush.
7. Coat the bolt threads and washer contact faces with MOLYKOTE G RAPID.

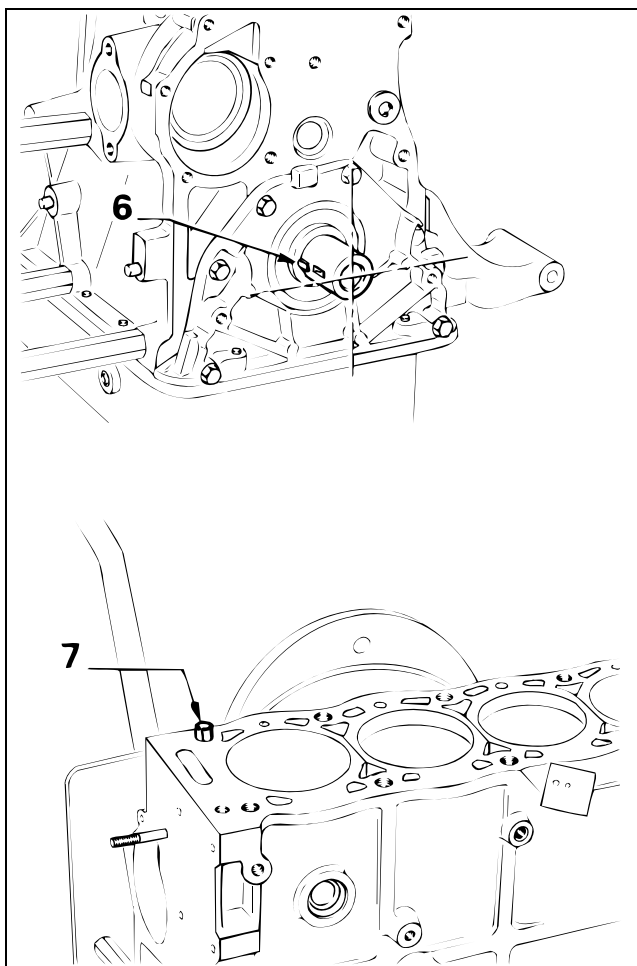


Figure 83

# Cylinder Head Tightening

1. Install new washers on the bolts.
2. Pre-tighten the bolts in the order shown (Fig. 84) to a torque of 30 Nm (22 ft-lb).
3. Tighten the bolts in the order shown to a torque of 70 Nm 52 ft-lb).
4. Tighten each bolt in the order shown an additional  $120^{\circ} \pm 2^{\circ}$ .

NOTE: The special cylinder head bolts (Item B) do not require re-tightening. The bolts can be removed and re-installed 5 times before replacing with new bolts.

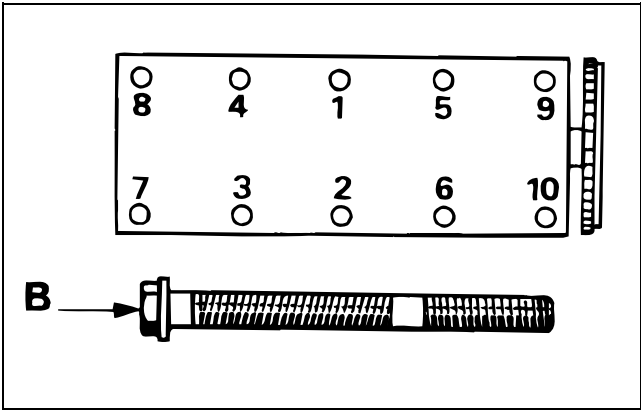


Figure 84

# Valve Clearance Adjustment

NOTE: If all valve parts are re-installed in their original location it should not be necessary to adjust valve clearance, unless the head has been machined or valves ground.

1. Install the camshaft gear. (Fig. 85, Item 1).
2. Check the valve clearance:

Units: mm

	Running Clearance	
Inlet	0.15	
Exhaust	0.30	
Tolerance	$\pm 0.04$	

Set "on the rock"	Inlet 4, Exhaust 4	Inlet 1, Exhaust 1
Check	Inlet 1, Exhaust 1	Inlet 4, Exhaust 4
	Inlet 2, Exhaust 3	Inlet 3, Exhaust 2

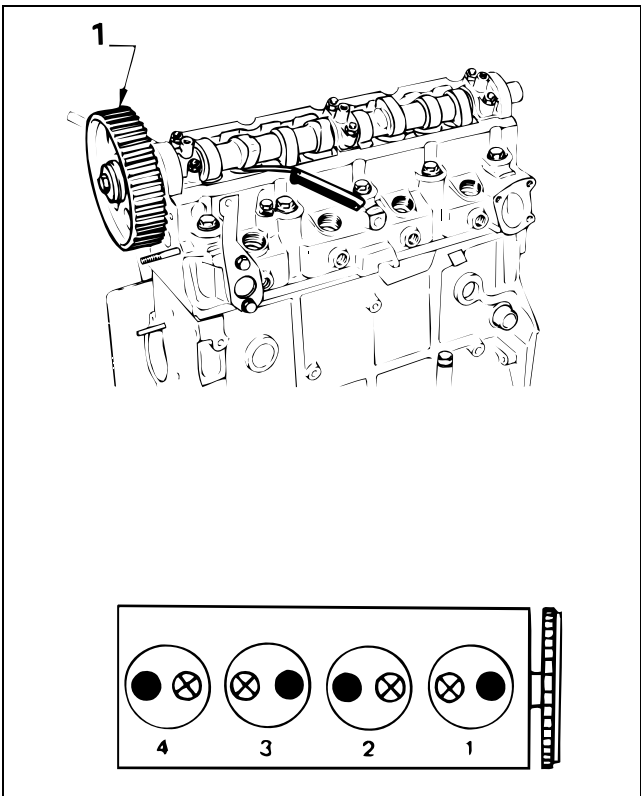


Figure 85

3. Remove the camshaft gear (Fig. 86, Item 1).
4. Remove the camshaft bearing caps (Item 2).
5. Remove the camshaft (Item 3).
6. Remove the tappets (Item 4).
7. Remove the basic shims (Item 5).
8. Determine the shim thickness to be fitted for each valve. Example:

Units: mm

	No. 1 Intake valve
Specified clearance	0.15
Clearance measured	0.25
Difference	+ 0.10
Shim installed	2.425 *
Shim to be installed	2.50
Clearance obtained	0.175

\* Basic shim

9. Install the shims as determined in step 8.
10. Install the tappets.

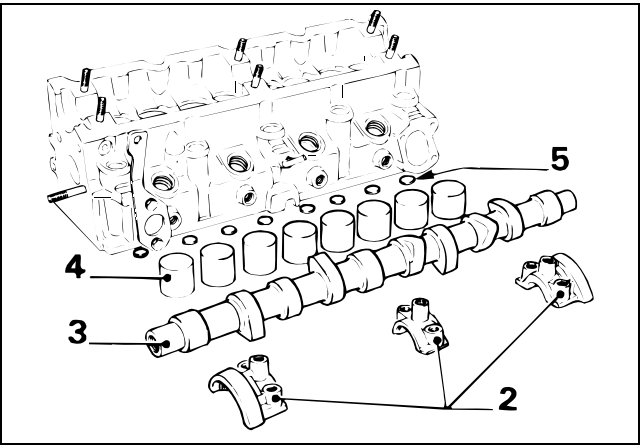


Figure 86

11. Apply a thin coat of Formetanch or Permatex No. 2 sealant to each end of the bearing housing at (Fig. 87, Item a).

12. Apply MOLYKOTE G RAPID to the bearing surfaces on the camshaft.

13. Install the camshaft (Item 3) with the DIST marking at the timing gear end.

14. Install the camshaft bearing caps (Item 2) as shown by cast-in markings.

15. Progressively tighten the bearing caps to 17.5 Nm (13 ft-lb).

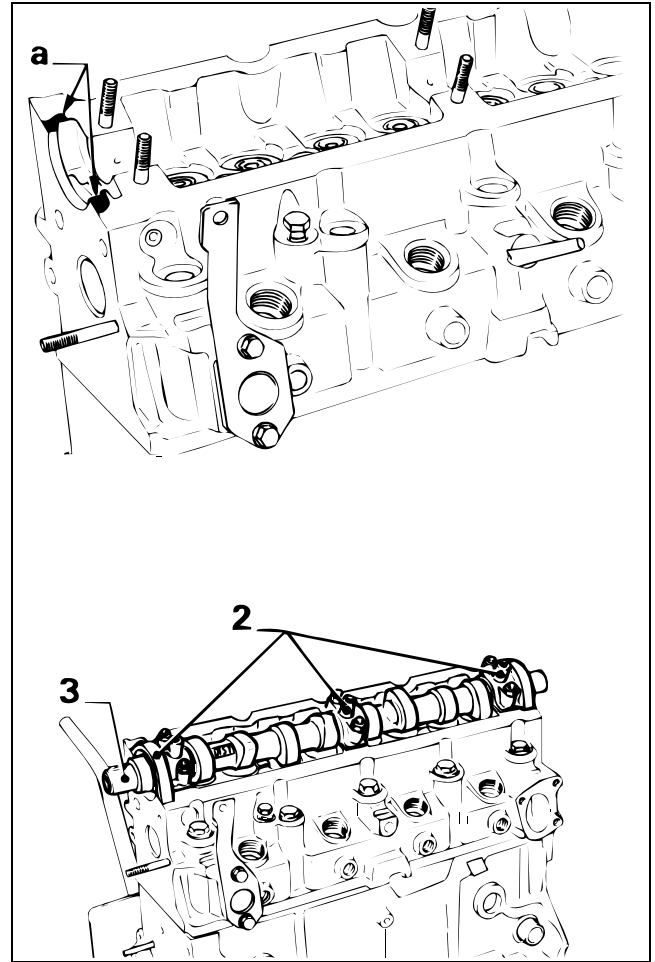


Figure 87

16. Install a new oil seal on tool TOR 976697 on the side where the inner flange is the farthest away (Fig. 88).

17. Use a camshaft gear or pulley bolt to install the two camshaft oil seals.

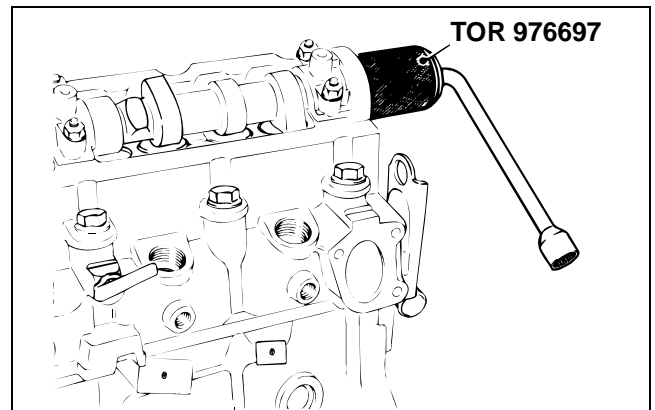


Figure 88

## Assembly of External Components

1. Install new fire ring washers (Fig. 89, Item 1), convex surface facing up.
2. Install new copper washers (Item 2).
3. Install the injectors and tighten to a torque of 90 Nm (66 ft-lb).
4. Install the pre-heat plugs (Item 4) and tighten to a torque of 22 Nm (16 ft-lb).
5. Install the thermostat housing (Item 5) and cover (Item 6), fitted with a new thermostat and gasket.
6. Install the cylinder head cover (Item 7), and tighten to a torque of 10 Nm (7 ft-lb).

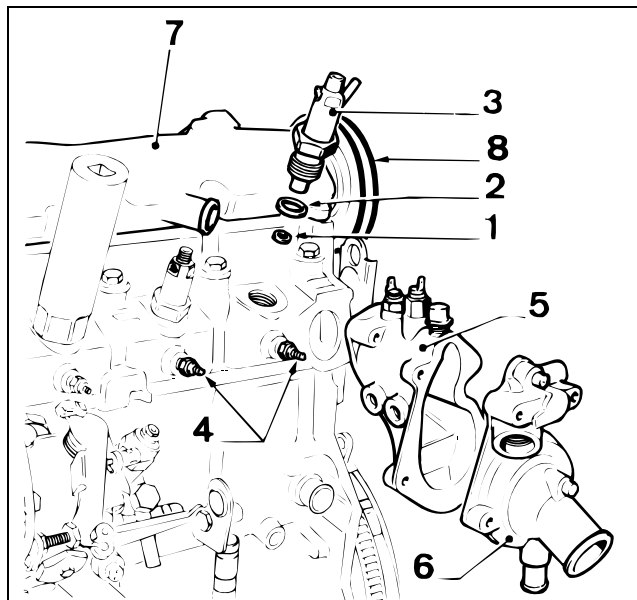


Figure 89

7. Install the pre-heat plug wires.
8. Install the breather pipe assembly, with oil filler pipes and filler orifice (Fig. 90, Item 13).
9. Install the injector pipes (Item 12).
10. Install the oil pressure switch (Item 14) and tighten to a torque of 27.5 Nm (20 ft-lb).
11. Install a new oil filter (Item 10). (See Break-in Engine After Overhaul.)
12. Install the alternator and alternator belt.
13. Install the water inlet housing.
14. Install the exhaust manifold with new seals.
15. Install the intake manifold.
16. Remove the engine from the stand.
17. Install the clutch housing centering pin.
18. Install the TDC sensor.

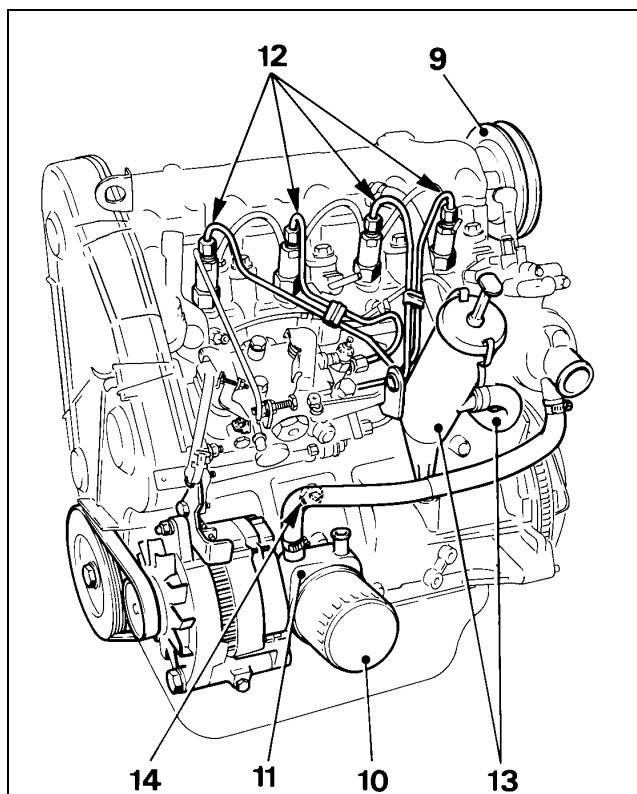


Figure 90

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## Break-in Engine After Overhaul

After disassembling or overhauling the engine, install the a new oil filter. Replace this filter with a new filter after the first 20 to 50 hours of operation.







# Hydraulic System

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# Specifications

Item	Description
Traction Pump Traction relief pressure Charge pressure	Variable axial piston pump 6000 ± 100 PSI at high idle 100 <sup>+25</sup> / - 10 PSI at 3000 ± 50 RPM
Charge/Auxiliary Pump Steering pressure	Gear pump with flow divider 1200 ± 100 PSI at 3000 ± 50 RPM
Traction Motor (front)	Fixed axial piston motor
Traction Motor (rear w/4WD)	Fixed axial piston pump
Lift Control Valve Lift relief pressure Counterbalance pressure Wing Lift Counterbalance pressure	Spool type directional control valve 2150 - 2300 PSI at high idle 600 - 650 PSI (hot oil) at 3000 ± 50 RPM 375 ± 25 PSI (hot oil) at 3000 ± 50 RPM
Hydraulic Filter	Spin-on cartridge type
Hydraulic Oil	* Mobil DTE 26 or equivalent
Reservoir	Approximately 6.5 gal. U.S.

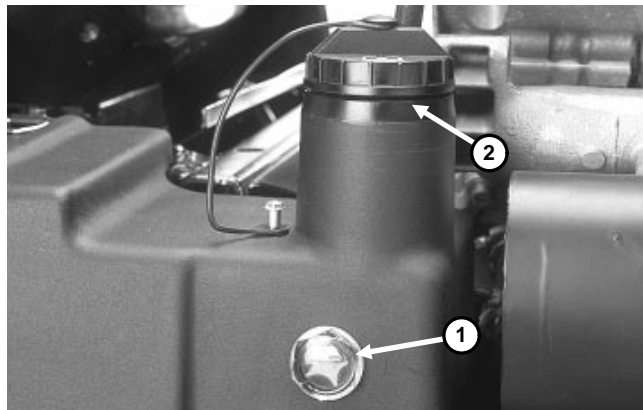


Figure 1

1. Sight gauge

2. Hydraulic reservoir cap

**\* Equivalent Hydraulic Oils  
(interchangeable):**

Shell Tellus 68  
Amoco Rykon Oil 68  
Conoco Super Hydraulic Oil 68  
Exxon Nuto 68  
Kendall Kenoil R & O AW 68  
Pennzoil Penreco 68  
Phillips Magnus A 68  
Standard Energol HLP 68  
Sun Sunvis 831 WR  
Union Unax AW 68  
Chevron AW Hydraulic Oil 68

# General Information

## Hydraulic Hoses

Hydraulic hoses are subject to extreme conditions such as, pressure differentials during operation and exposure to weather, sun, chemicals, very warm storage conditions or mishandling during operation or maintenance. These conditions can cause damage or premature deterioration. Some hoses, such as reel motor hoses, are more susceptible to these conditions than others. Inspect the hoses frequently for signs of deterioration or damage.

When replacing a hydraulic hose, be sure that the hose is straight (not twisted) before tightening the fittings. This can be done by observing the imprint on the hose. Use two wrenches; one to hold the hose straight and one to tighten the hose swivel nut onto the fitting.



### WARNING

**Before disconnecting or performing any work on the hydraulic system, all pressure in the system must be relieved by stopping the engine and opening the bypass valve.**

**Keep body and hands away from pin hole leaks or nozzles that eject hydraulic fluid under high pressure. Use paper or cardboard, not hands, to search for leaks. Hydraulic fluid escaping under pressure can have sufficient force to penetrate the skin and do serious damage. If fluid is injected into the skin, it must be surgically removed within a few hours by a doctor familiar with this type of injury or gangrene may result.**

## Hydraulic Fitting Installation

### O-Ring Face Seal (Fig. 2, 3)

1. Make sure both threads and sealing surfaces are free of burrs, nicks, scratches, or any foreign material.
2. Make sure the O-ring is installed and properly seated in the groove. It is recommended that the O-ring be replaced any time the connection is opened.
3. Lubricate the O-ring with a light coating of oil.
4. Put the tube and nut squarely into position on the face seal end of the fitting and tighten the nut until finger tight.
5. Mark the nut and fitting body. Hold the body with a wrench. Use another wrench to tighten the nut to the correct flats from finger tight (F.F.T.). The markings on the nut and fitting body will verify that the connection has been tightened.

Size	F.F.T.
4 (1/4 in. nominal hose or tubing)	.75 ± .25
6 (3/8 in.)	.75 ± .25
8 (1/2 in.)	.75 ± .25
10 (5/8 in.)	1.00 ± .25
12 (3/4 in.)	.75 ± .25
16 (1 in.)	.75 ± .25

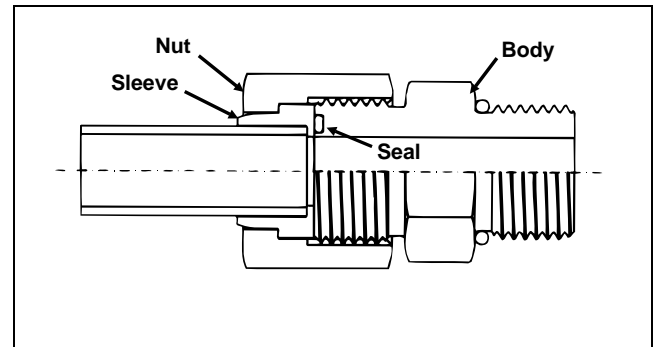


Figure 2

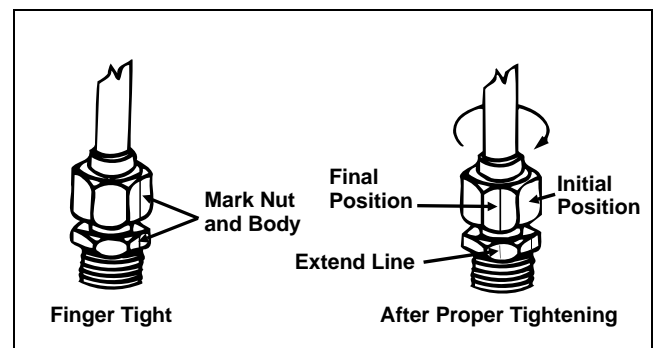


Figure 3

### SAE Straight Thread O-Ring Port - Non-adjustable (Fig. 4)

1. Make sure both threads and sealing surfaces are free of burrs, nicks, scratches, or any foreign material.
2. Always replace the O-ring seal when this type of fitting shows signs of leakage.
3. Lubricate the O-ring with a light coating of oil.
4. Install the fitting into the port and tighten it down full length until finger tight.
5. Tighten the fitting to the correct flats from finger tight (F.F.F.T.).

Size	F.F.F.T.
4 (1/4 in. nominal hose or tubing)	1.00 ± .25
6 (3/8 in.)	1.50 ± .25
8 (1/2 in.)	1.50 ± .25
10 (5/8 in.)	1.50 ± .25
12 (3/4 in.)	1.50 ± .25
16 (1 in.)	1.50 ± .25

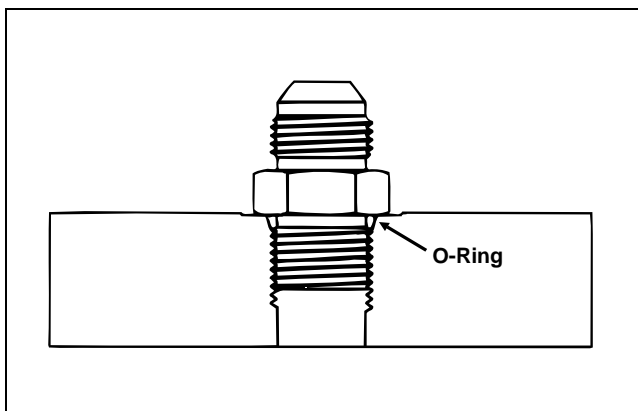


Figure 4

### SAE Straight Thread O-Ring Port - Adjustable (Fig. 5, 6)

1. Make sure both threads and sealing surfaces are free of burrs, nicks, scratches, or any foreign material.
2. Always replace the O-ring seal when this type of fitting shows signs of leakage.
3. Lubricate the O-ring with a light coating of oil.
4. Turn back the jam nut as far as possible. Make sure the back up washer is not loose and is pushed up as far as possible (Step 1).
5. Install the fitting into the port and tighten finger tight until the washer contacts the face of the port (Step 2).
6. To put the fitting in the desired position, unscrew it by the required amount, but no more than one full turn (Step 3).
7. Hold the fitting in the desired position with a wrench and turn the jam nut with another wrench to the correct flats from finger tight (F.F.F.T.) (Step 4)

Size	F.F.F.T.
4 (1/4 in. nominal hose or tubing)	1.00 ± .25
6 (3/8 in.)	1.50 ± .25
8 (1/2 in.)	1.50 ± .25
10 (5/8 in.)	1.50 ± .25
12 (3/4 in.)	1.50 ± .25
16 (1 in.)	1.50 ± .25

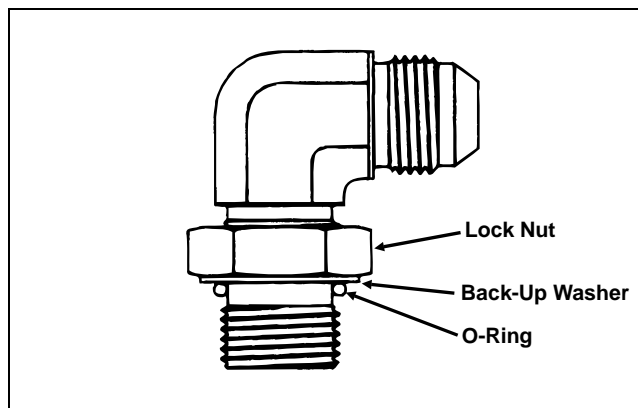


Figure 5

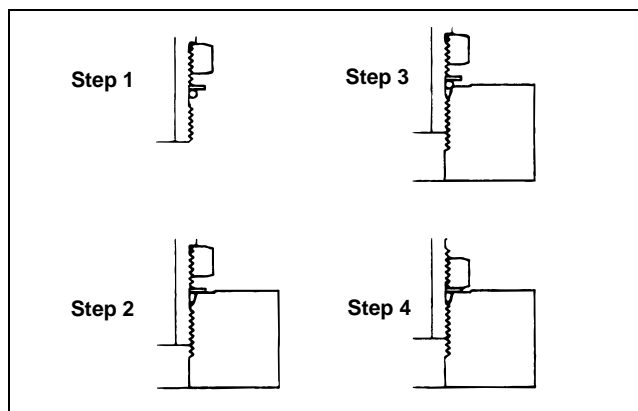
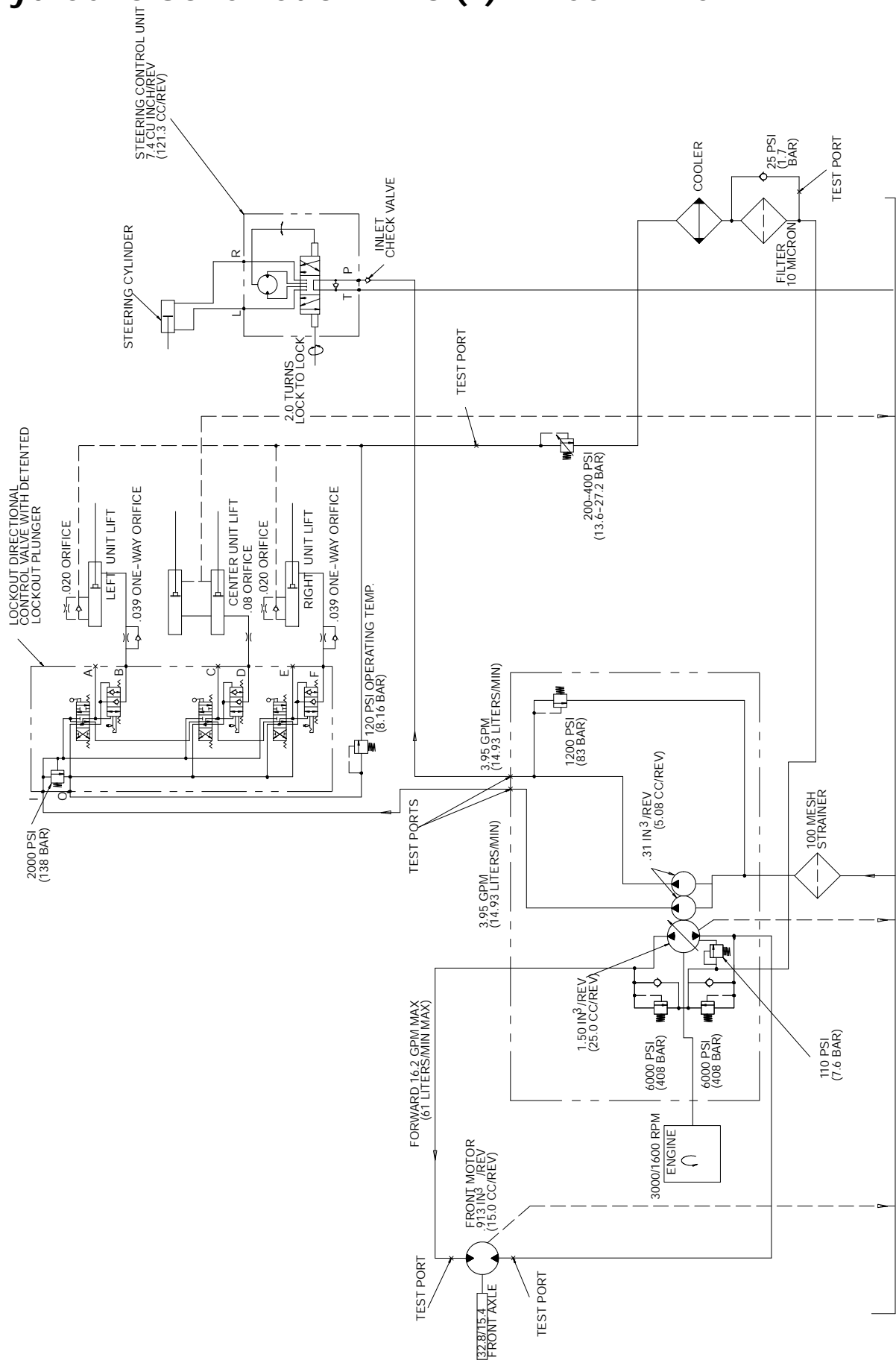


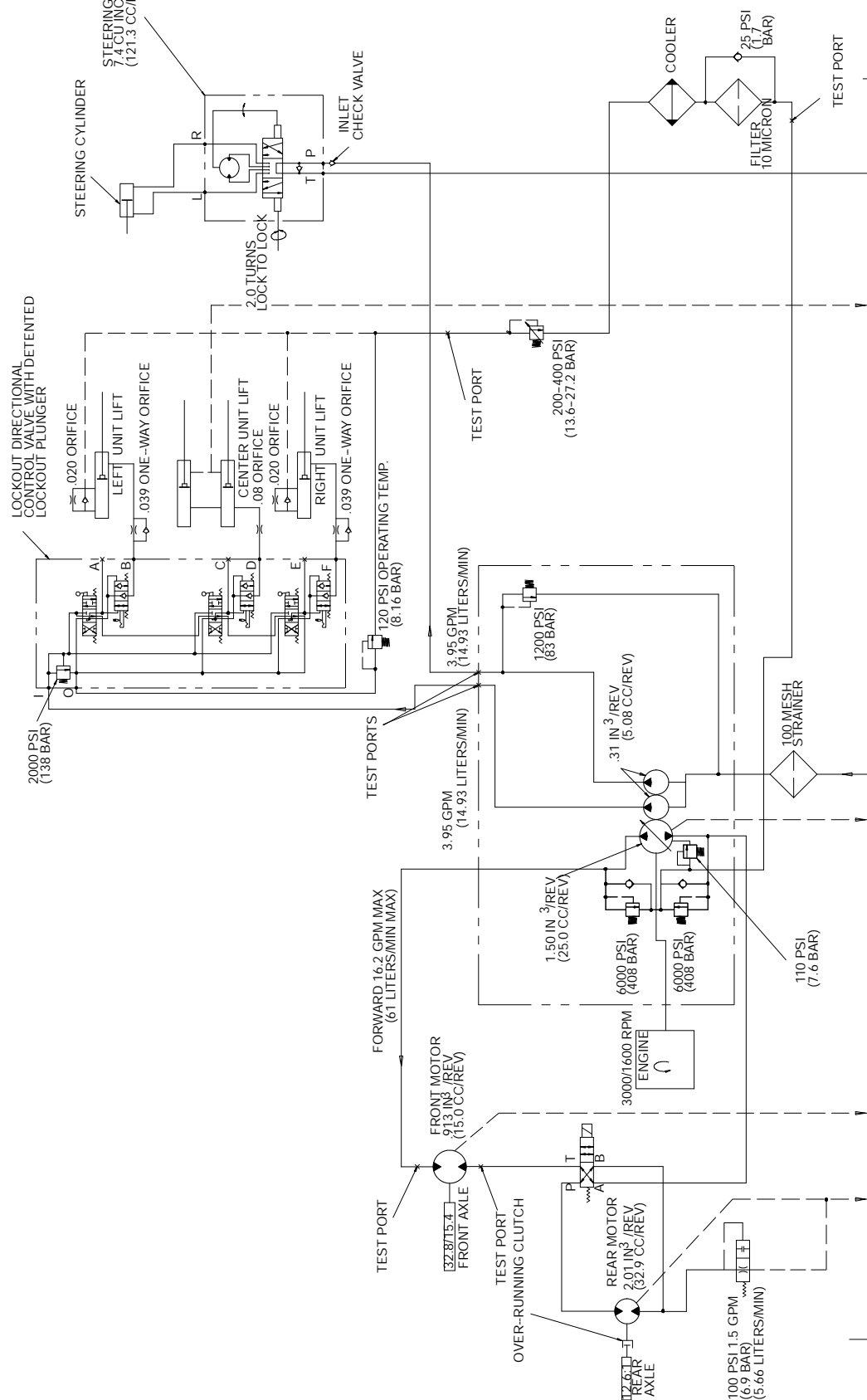
Figure 6

# Hydraulic Schematic – Two (2) Wheel Drive



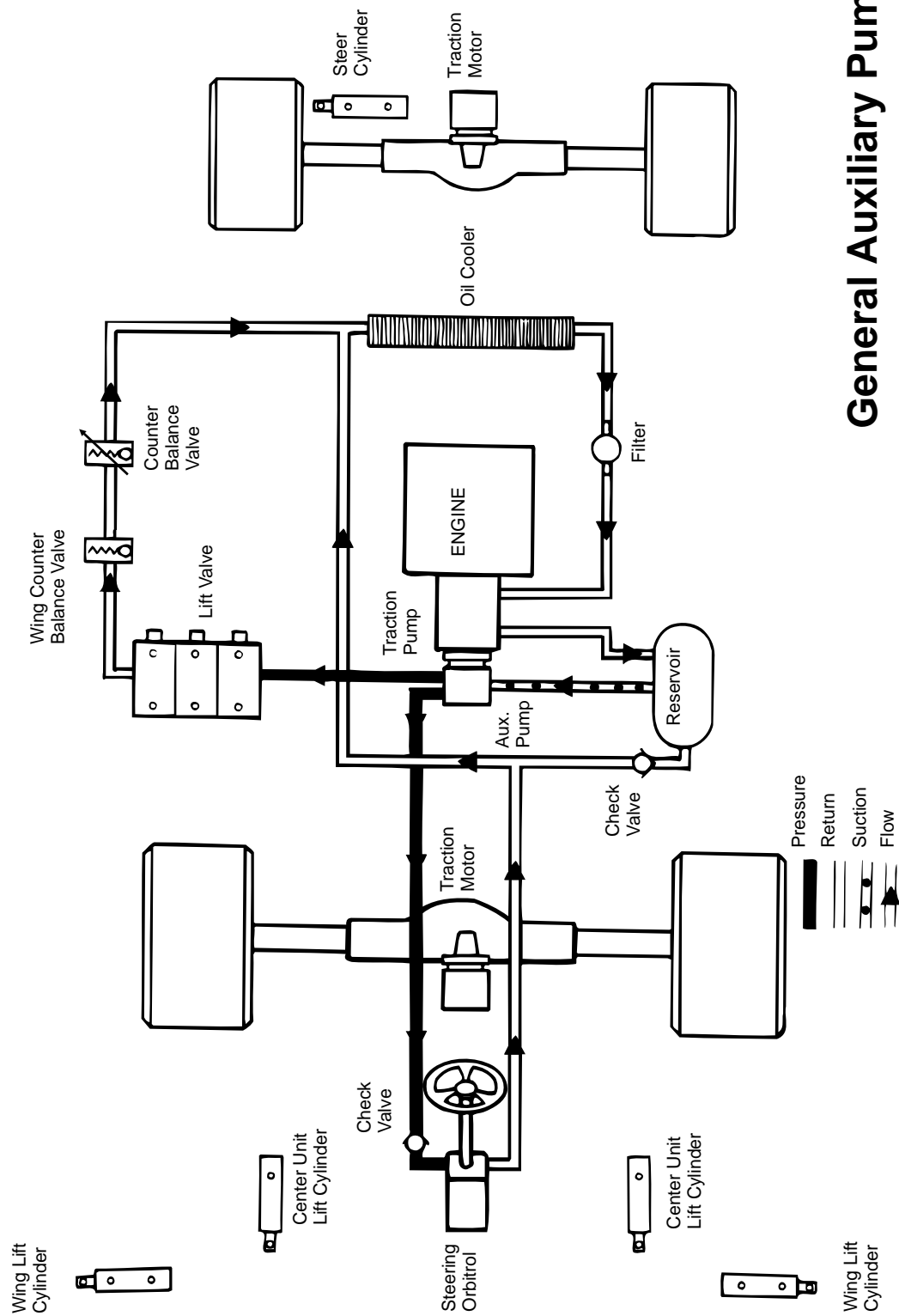
Hydraulic System

## Hydraulic Schematic – Four (4) Wheel Drive



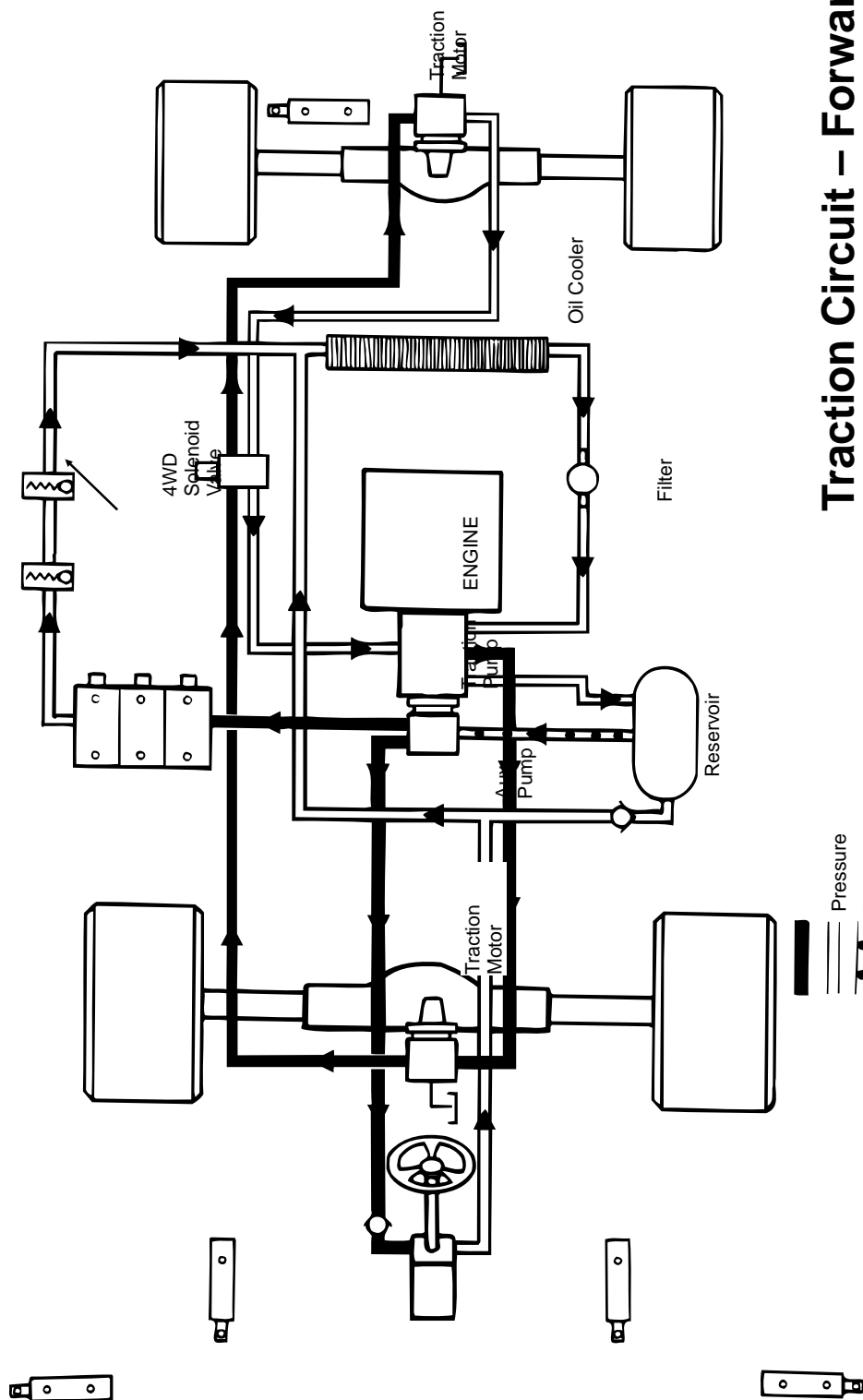
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# Hydraulic Flow Diagrams



## General Auxiliary Pump Flow

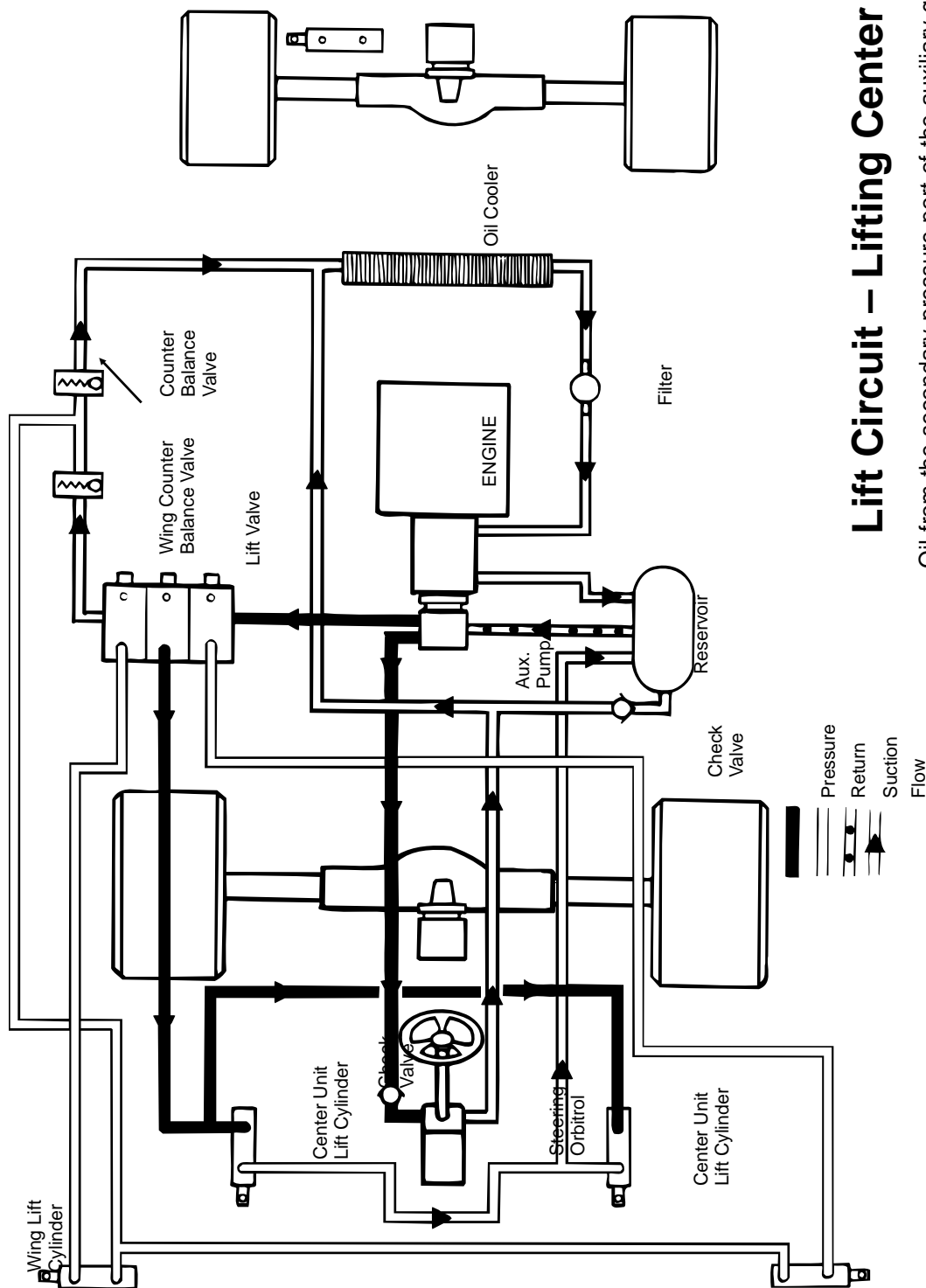
With all controls in neutral and the engine running, oil is drawn from the reservoir by the auxiliary pump. This gear-type pump has a flow divider cover. Priority flow goes to the steering valve, then through the oil cooler, filter, and back to the traction pump. Secondary flow goes to the lift valve, then through the counterbalance valve, oil cooler and back to the traction pump. Return flow from the auxiliary circuit provides charge oil for the closed loop traction circuit. Excess return flow goes over the charge relief valve in the traction pump and back to reservoir.



## Traction Circuit – Forward

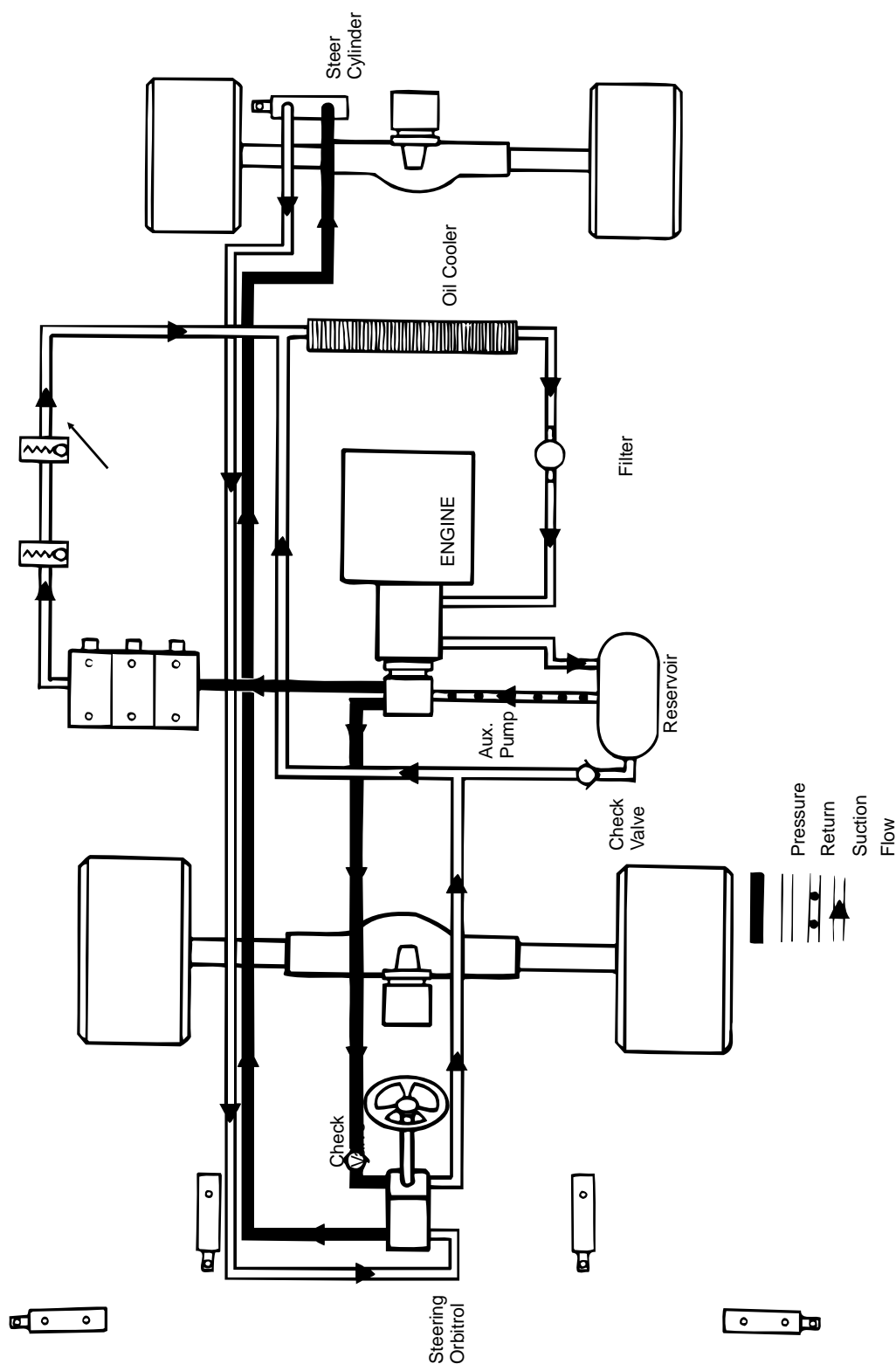
When the top of the traction pedal is pushed down, a variable displacement hydrostatic piston pump creates a flow of oil to a fixed displacement piston motor mounted on the two-speed axle to drive the machine forward. On **two wheel drive** units, this flow returns to the traction pump and continues to operate in a closed loop. **Four wheel drive** units have another piston motor connected in series with the front motor and mounted to the steerable rear axle. On these units, flow is from the pump to the front motor, through a solenoid rear valve, then to the rear motor and back to the pump, continuing in a closed loop. An interlock switch on the front axle controls the 4wd solenoid valve to engage four wheel drive only when the transmission is in low gear. When in four wheel drive, an over-running clutch between the motor and rear axle automatically engages the rear axle only when the front wheels begin to slip.





## Lift Circuit – Lifting Center Cutting Unit

Oil from the secondary pressure port of the auxiliary gear type pump goes to the three-spool valve, then through the counterbalance valve, oil cooler, filter, and back to reservoir. Each lift valve spool controls separate lift cylinders. Check valves in each spool section hold the cutting units in the raised position. When a lift lever is moved to the lift position, the valve spool moves to direct oil flow to the lift cylinder, lifting the cutting unit. An orifice in the lift port of each cylinder limits the speed of cutting unit lifting and lowering. A counterbalance relief valve in the return line creates a constant back pressure in the lift circuit to transfer some of the cutting unit weight to the traction unit.



## Steering Circuit – R.H. Turn

Oil flows from the priority pressure port of the gear type auxiliary pump to the power steering valve, then through the oil cooler, filter, and back to the reservoir. Turning the steering wheel to the right (clockwise) moves the control spool in the steering valve to meter oil to the steering cylinder for a right turn. Turning the steering wheel to the left (counterclockwise) has the opposite effect. Cylinder movement forces oil out the other end of the cylinder, back to the steering valve which directs it back to reservoir.

# Special Tools

NOTE: Order special tools from the *TORO SPECIAL TOOLS AND APPLICATIONS GUIDE (COMMERCIAL PRODUCTS)*. Some tools may be listed in the Groundsmaster 455-D Parts Catalog. Some tools may also be available from a local supplier.

## Hydraulic Pressure Test Kit

Used to take various pressure readings for diagnostic tests. Quick disconnect fittings provided attach directly to mating fittings on machine test ports without tools. A high pressure hose is provided for remote readings. Contains one each, 1000, 5000 and 10000 PSI gauges. Use gauges as recommended in Testing section of this chapter.

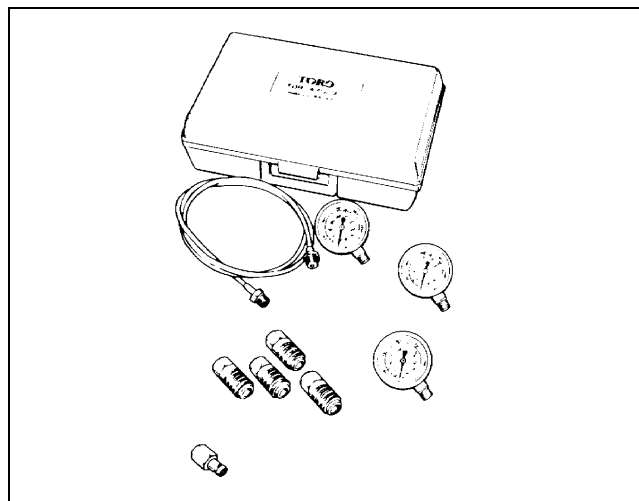


Figure 7

## Hydraulic Tester - With Pressure and Flow Capabilities

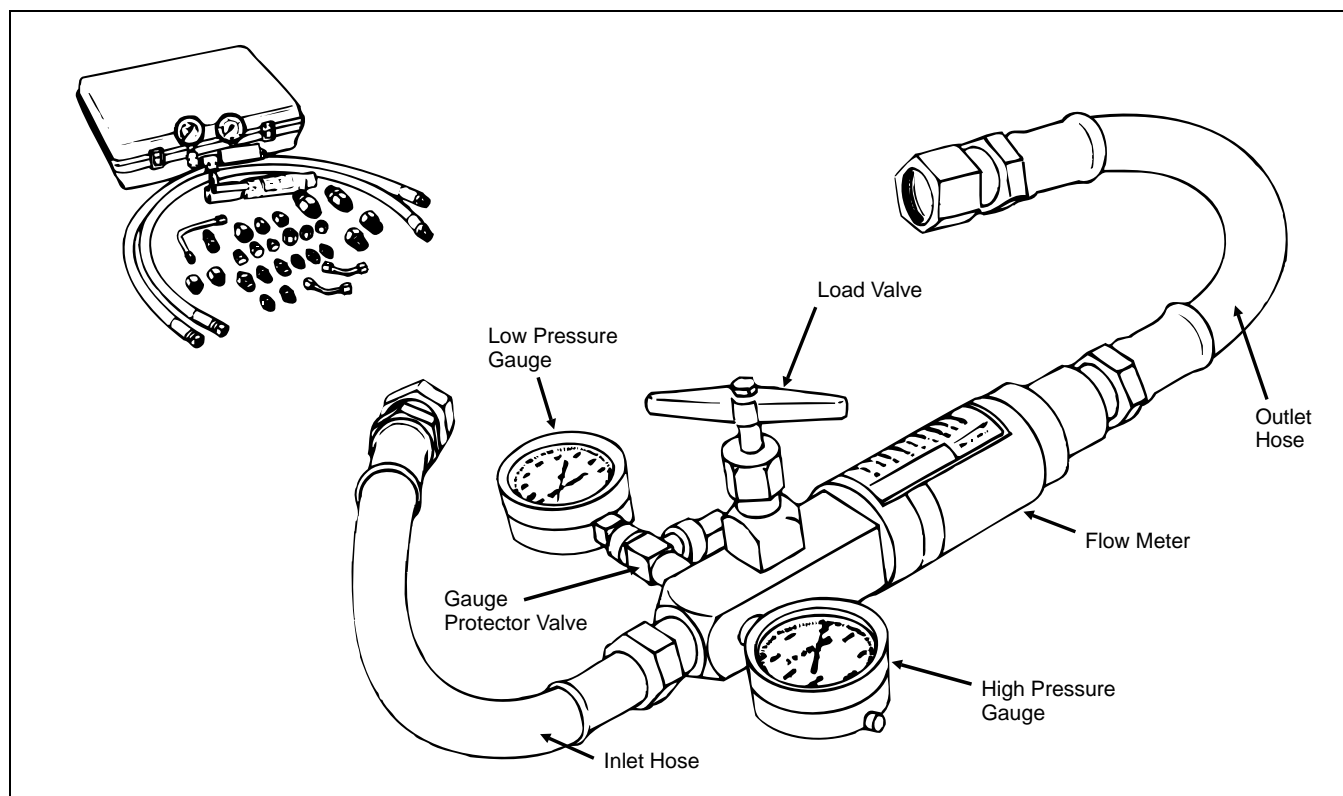


Figure 8

You must have o-ring face seal (ORFS) adapter fittings for this tester to use it on the Groundsmaster 455-D.

1. **INLET HOSE:** Hose connected from the system circuit to the inlet side of the hydraulic tester.

2. **LOAD VALVE:** If required, upon turning the valve to restrict flow, a simulated working load is created in the circuit.

3. **LOW PRESSURE GAUGE:** Low range gauge to provide accurate reading at low pressure, 0 - 1000 PSI.

This gauge has a protector valve which cuts out when pressure is about to exceed the normal range for the gauge. The cutout pressure is adjustable.

4. **HIGH PRESSURE GAUGE:** High range gauge to accommodate pressure beyond the capacity of the low pressure gauge, 0 - 10,000 PSI.

5. **FLOW METER:** This meter measures actual oil flow in the operation circuit, with a gauge rated at 15 GPM.

6. **OUTLET HOSE:** Hose from the outlet side of the hydraulic tester to be connected to the hydraulic system circuit.

# Troubleshooting

The cause of an improperly functioning hydraulic system is best diagnosed with the use of proper testing equipment and a thorough understanding of the complete hydraulic system.

A hydraulic system with an excessive increase in heat or noise is a potential failure. Should either of these conditions be noticed, immediately stop the machine, turn off the engine, locate the cause of the trouble, and correct it before allowing the machine to be used again. Continued use of an improperly functioning hydraulic

system could lead to extensive internal component damage.

The charts that follow contain detailed information to assist in troubleshooting. There may possibly be more than one cause for a machine malfunction. All causes should be checked in the order in which they are listed on the charts.

Refer to the Testing section of this Chapter for precautions and specific test procedures.

## System Operates Hot

Cause	Correction
Cooling system not operating properly.	Clean screen, oil cooler & radiator. Repair fan or belt. Check coolant level and add coolant if necessary. Make sure radiator screen is properly sealed.
Low engine RPM.	Adjust - use tachometer.
Hydraulic oil level too low.	Fill to proper level.
Kinked or severely bent hose or tubing.	Replace kinked or bent hose or tubing.
Traction circuit working pressure too high - TEST NO. 1.	Inspect brakes for binding and adjust or repair if necessary.  Check for other cause of excessive machine load and correct.
Damaged pump or motor(s).	Repair or replace pump or motor(s).

## Machine Travels In One Direction Only

Cause	Correction
Traction control linkage damaged or out of adjustment.	Repair control linkage.
Pump charge check/relief valves defective.	Inspect and clean or replace pump check/relief valves.

---

## Traction Response Is Sluggish

Cause	Correction
Brakes dragging.	Inspect brakes and adjust or repair if necessary.
Charge pressure low - TEST NO. 6. NOTE: Counterbalance pressure will also be affected.	Inspect charge relief valve and adjust or repair if necessary.  Inspect auxiliary pump and repair or replace if necessary NOTE: Steering and lift will also be affected if auxiliary pump is damaged.
Pump or motor damaged.	Inspect and repair or replace traction pump or motor if necessary.

---

## Machine Will Not Travel In Either Direction

Cause	Correction
Front axle shift lever in neutral (middle) position.	Move shift lever to engage transmission.
Damaged front axle or rear 4wd axle.	Repair axle.
Brakes engaged.	Inspect brakes and adjust or repair if necessary.
Hydraulic oil level too low.	Fill to proper level.
Control linkage damaged or out of adjustment.	Repair control linkage.
Charge pressure low - TEST NO. 6. NOTE: Counterbalance pressure will also be affected.	Inspect charge relief valve and adjust or repair if necessary.  Inspect auxiliary pump and repair or replace if necessary NOTE: Steering and lift will also be affected if auxiliary pump is damaged.
Traction pressure too low - TEST NO. 1.	Inspect traction pump check/relief valves and repair or replace if necessary.  Check for damaged pump or motor(s) and repair or replace if necessary.

## Four Wheel Drive Does Not Engage

Cause	Correction
Front axle shift lever in "HI" (forward) position.	Front axle shift lever must be in "LOW" (rear) position for four wheel drive to engage.
Electrical problem.	Check for faulty front axle HI/LOW switch, four wheel drive solenoid or wiring and repair if necessary.
Faulty four wheel drive solenoid valve.	Inspect and clean solenoid valve and repair or replace if necessary.
Faulty roller clutch.	Replace roller clutch.
Faulty rear axle hydraulic motor.	Repair or replace motor.

## Four Wheel Drive Does Not Disengage

Cause	Correction
Electrical problem.	Check for faulty front axle HI/LOW switch, or wiring and repair if necessary.
Four wheel drive solenoid valve sticking.	Inspect solenoid valve for damage or sticking in on position and clean or replace valve if necessary.
Faulty roller clutch.	Replace roller clutch.

---

## Cutting Unit Does Not Lift or Lift Too Slowly

Cause	Correction
Hydraulic oil level too low.	Fill to proper level.
Low engine RPM.	Adjust engine RPM - use tachometer.
Lift arm or cylinder pivots binding.	Lubricate bushings. Inspect for damage. Repair or replace damaged parts.
Wing deck break-away spring mechanism binding.	Lubricate and inspect for damaged or worn parts. Repair or replace damaged or worn parts.
Lift cylinder damaged.	Check lift cylinder(s). Repair or replace if necessary.
Low counterbalance pressure - TEST NO. 2, 3.	Adjust counterbalance pressure or replace counterbalance relief valve if necessary.
Low lift pressure - TEST NO. 5.	<p>Check for restriction in pump intake line or strainer and repair if necessary.</p> <p>Check lift cylinder(s) for internal leakage and repair or replace if necessary.</p> <p>Clean relief valve in lift control valve and adjust if necessary by adding required shims.</p> <p>Inspect lift valve for internal leakage or improper operation and repair or replace if necessary.</p> <p>Inspect steering/lift pump and priority flow valve for wear or damage and repair or replace if necessary.</p>



## Cutting Unit Will Not Drop or Follow Ground Contours

Cause	Correction
Low engine RPM.	Adjust engine RPM - use tachometer.
Lift arm or cylinder pivots binding.	Lubricate bushings. Inspect for damage. Repair or replace damaged parts.
Lift cylinder damaged.	Check lift cylinder(s) and repair or replace if necessary.
Counterbalance pressure too high - TEST NO. 2, 3.	Adjust counterbalance pressure or replace counterbalance relief valve if necessary.
Orifice in hydraulic line plugged.	Clean orifice.
Worn or damaged spool detent in lift valve.	Repair or replace.
Faulty lift valve.	Repair or replace lift valve.

## Cutting Unit Drops From Raised Position With Lift Valve in Centered Position

Cause	Correction
Improperly positioned valve.	Instruct operator.
Worn detent(s) in lift valve.	Repair lift valve.
Internal leakage of lift cylinder(s)	Check lift cylinder(s) and repair or replace if necessary.
Lift cylinder hydraulic lines or fittings leaking.	Check for leaks. Correct any leaks by replacing o-rings and tightening connection properly. Replace lines or fittings if necessary.
Faulty lift valve lockout assembly.	<p>Check for damaged o-rings on lockout plugs or seats and repair if necessary.</p> <p>Check for damaged or worn lockout poppet assembly and replace if necessary.</p> <p>Check for broken lockout spring and replace if necessary.</p>

---

## Cutting Unit Lowers or Raises Too Quickly

Cause	Correction
Missing or improperly installed orifice in hydraulic line.	Properly install orifice between left valve and hydraulic hose to hydraulic lift cylinder(s). NOTE: Orifice must be installed to avoid interference with adapter fitting.

---

## Steering Loss

Cause	Correction
Steering linkage or cylinder pivots damaged, worn, or binding.	Lubricate bushings. Inspect for damage. Repair or replace damaged parts.
Low steering pressure - TEST NO. 4.	<p>Check for restriction in pump intake line or strainer and repair if necessary.</p> <p>Check steering cylinder for internal leakage and repair or replace if necessary.</p> <p>Clean relief valve in steering pump and adjust or replace if necessary.</p> <p>Inspect steering/lift pump for wear or damage and repair or replace if necessary.</p>
Steering control unit faulty.	Repair or replace steering control unit.

NOTE: Steering loss after washing machine can be the result of "thermal shock". Normal functions will return after steering control unit temperature stabilizes. To prevent damage to steering control unit, DO NOT attempt to turn steering wheel until temperature stabilizes when thermal shock is noted.

# Testing

The most effective method for isolating problems in the hydraulic system is by using hydraulic test equipment such as pressure gauges and flow meters in the circuits during various operational checks. (See the Special Tools section in this Chapter.)



## CAUTION

**Failure to use gauges with the recommended pressure (psi) rating as listed in the test procedures could result in damage to the gauge and possible personal injury from leaking hot oil.**

### Before Performing Hydraulic Tests

All obvious areas such as oil supply, filter, binding linkage, loose fasteners, or improper adjustments must be checked before assuming that a hydraulic component is the source of the problem being experienced.



## WARNING

**Before disconnecting or performing any work on the hydraulic system, all pressure in the system must be relieved by stopping the engine and lowering the cutting units.**

**Keep body and hands away from pin hole leaks or nozzles that eject hydraulic fluid under high pressure. Use paper or cardboard, not hands, to search for leaks. Hydraulic fluid escaping under pressure can have sufficient force to penetrate skin and do serious damage. If fluid is injected into the skin, it must be surgically removed within a few hours by a doctor familiar with this type of injury or gangrene may result.**

1. Thoroughly clean the machine before disconnecting or disassembling any hydraulic components. Always keep in mind the need for cleanliness when working on hydraulic equipment.

2. Put caps or plugs on any hydraulic lines left open or exposed during testing or removal of components.

3. The engine must be in good operating condition. Use a tachometer when making a hydraulic test. Engine speed can affect the accuracy of the tester readings.

4. To prevent damage to tester or components, the inlet and the outlet hoses must be properly connected, and not reversed (tester with pressure and flow capabilities).

5. To minimize the possibility of damaging components, completely open load valve in hydraulic tester (if using tester with pressure and flow capabilities).

6. Install fittings finger tight, far enough to insure that they are not cross-threaded, before tightening with a wrench.

7. Position the tester hoses so that rotating machine parts will not make contact with them and result in hose or tester damage.

8. Check the oil level in the reservoir.

9. Check the control linkage for improper adjustment, binding or broken parts.

10. All hydraulic tests should be made with the hydraulic oil at normal operating temperature.

## TEST NO. 1: Checking Traction Circuit Working Pressure or Relief Pressure

### WORKING Pressure Check:

1. Make sure hydraulic oil is at normal operating temperature by operating machine for approximately 10 minutes.
2. Lower cutting units, engage parking brake and stop the engine.
3. Raise seat to get access to hydraulic test fittings. Remove access cover from in front of auxiliary pump.
4. Install a 10,000 PSI gauge with extension hose onto the traction circuit quick disconnect fitting for the function to be checked. Install gauge and hose so gauge can be observed while sitting on seat, BUT WILL NOT CONTACT CUTTING UNIT WHEN RAISED.
5. Operate machine while monitoring gauge.

RANGE OF TESTER READINGS: 100 - 6100 PSI

### RELIEF Pressure Check



#### CAUTION

**Move machine to an open area away from people and obstructions.**

6. Set traction pedal stop for minimum ground speed (1 MPH).
7. Start the engine and move throttle to full speed (3000 RPM).
8. Release parking brake.
9. Engage the traction pedal to start machine in motion.
10. Maintain traction pedal engagement while momentarily engaging the brakes to bring the unit to a halt and read gauge.

TESTER READING TO BE  $6000 \pm 100$  PSI.

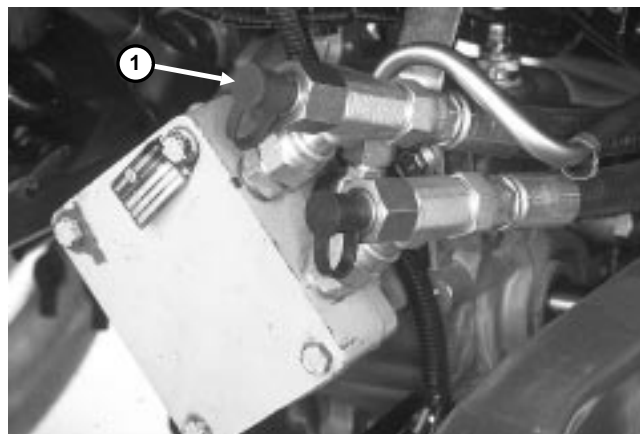


Figure 9

1. Traction FORWARD test port

## TEST NO. 2: Checking Counterbalance Pressure

1. Make sure hydraulic oil is at normal operating temperature by operating machine for approximately 10 minutes.
2. Lower cutting units, engage parking brake and stop the engine.
3. Raise and support seat to get access to hydraulic test fittings.
4. Install a 1000 PSI gauge into the counterbalance/lift circuit quick disconnect fitting.
5. Start the engine, move throttle to full speed (3000 RPM) and observe gauge.

TESTER READING: 600 - 650 PSI (oil at normal operating temperature)

### Counterbalance Relief Valve Adjustment

6. If necessary adjust the relief valve screw until the desired pressure is attained. Adjust nearer the high end of the range for improved hill climbing or nearer the low end for improved quality of cut.



#### CAUTION

When adjusting counterbalance relief valve, do not unscrew relief valve adjuster too far. Watch pressure gauge while adjusting valve. Stop unscrewing valve adjuster when pressure no longer decreases.

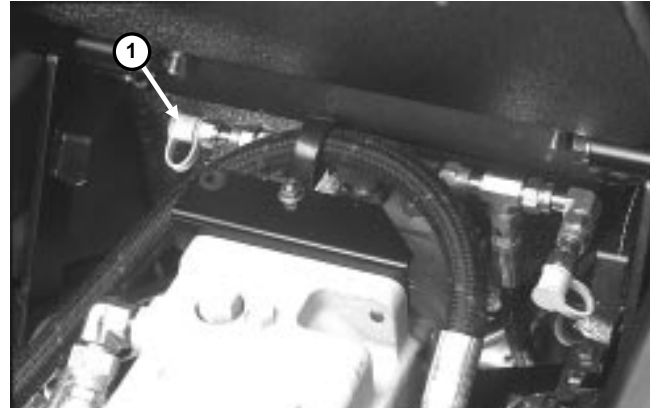


Figure 10

1. Counterbalance/lift circuit test port

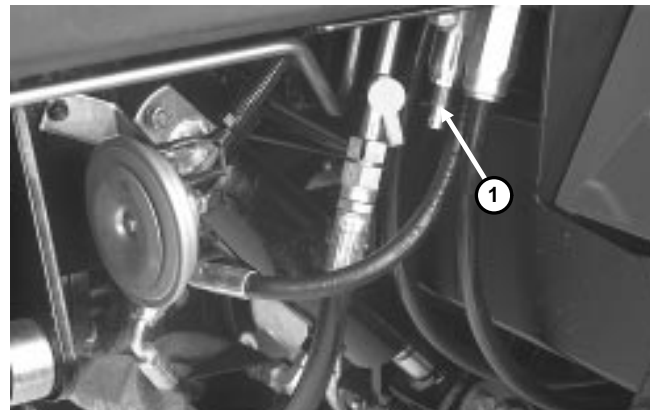


Figure 11

1. Counterbalance relief valve

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## TEST NO. 3: Checking Wing Deck Counterbalance Pressure

### Wing Deck Counterbalance Pressure

1. Make sure hydraulic oil is at normal operating temperature by operating machine for approximately 10 minutes.
2. Lower cutting units, engage parking brake and stop the engine.
3. Install a 1000 PSI gauge into the wing decks counterbalance quick disconnect fitting.
4. Start the engine, move throttle to full speed (3000 RPM) and observe gauge.

TESTER READING: 350 - 400 PSI (oil at normal operating temperature)

NOTE: The wing deck counterbalance valve is not adjustable.

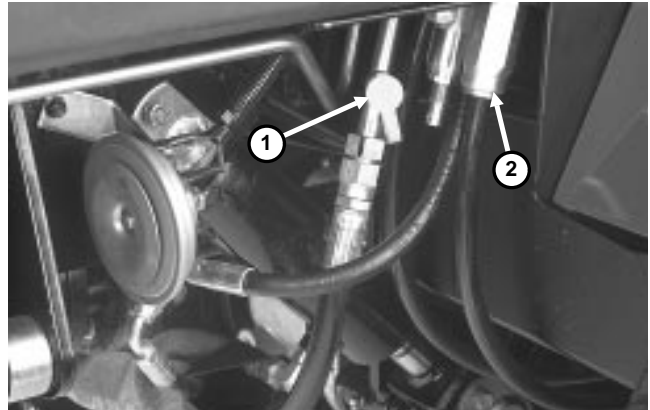


Figure 12

1. Wing deck counterbalance test port
2. Wing deck counterbalance relief valve (non-adjustable)

---

## TEST NO. 4: Checking Steering Circuit Working Pressure or Relief Pressure

### WORKING Pressure Check:

1. Make sure hydraulic oil is at normal operating temperature by operating machine for approximately 10 minutes.
2. Lower cutting units, engage parking brake and stop the engine.
3. Raise and support the seat to get access to hydraulic test fittings.
4. Install a 5000 PSI gauge onto steering circuit quick disconnect fitting.
5. Operate machine while monitoring gauge.

RANGE OF TESTER READINGS 0 - 1300 PSI.

### RELIEF Pressure Check:

6. With engine running, turn the steering wheel until heavy resistance is felt indicating that the cylinder has reached maximum stroke.
7. Momentarily hold steering wheel against resistance and read gauge.

TESTER READING TO BE  $1200 \pm 100$  PSI.

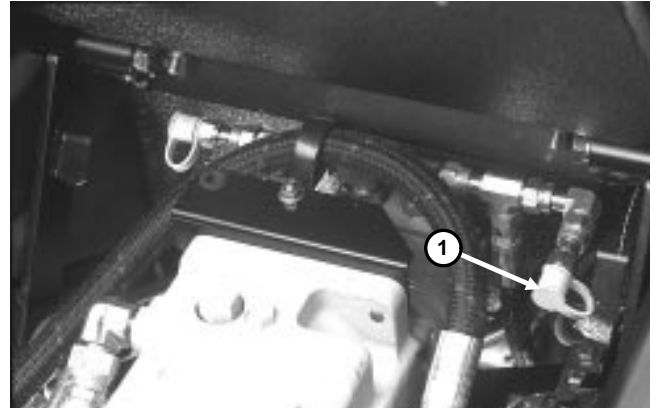


Figure 13

1. Steering circuit test port

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## TEST NO. 5: Checking Lift Circuit Working Pressure or Relief Pressure

### WORKING Pressure Check:

1. Make sure hydraulic oil is at normal operating temperature by operating machine for approximately 10 minutes.
2. Lower cutting units, engage parking brake and stop the engine.
3. Raise and support seat to get access to hydraulic test fittings. Remove access cover from in front of auxiliary pump.
4. Install a 5000 PSI gauge onto lift circuit quick disconnect fitting. Put gauge and hose through opening below seat in front of auxiliary pump so gauge can be observed while sitting on seat.
5. Raise center cutting unit while monitoring gauge.

RANGE OF TESTER READINGS 600 - 2800 PSI  
when counterbalance setting is 600 PSI.

NOTE: Changes in counterbalance setting will affect the lift circuit relief pressure.

### RELIEF Pressure Check:

6. With engine running at full speed, engage control lever into the "LIFT" position.
7. Momentarily hold the lever in the engaged position after full cylinder extension and read gauge.

TESTER READING TO BE 2600 - 2800 PSI when  
counterbalance setting is 600 PSI.

NOTE: Changes in counterbalance setting will affect the lift circuit relief pressure.

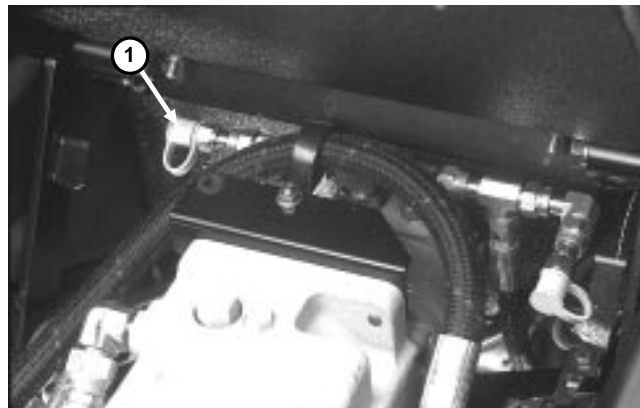


Figure 14

1. Lift circuit test port



## TEST NO. 6: Checking Charge Pressure

1. Make sure hydraulic oil is at normal operating temperature by operating machine for approximately 10 minutes.
2. Lower cutting units, engage parking brake and stop the engine.
3. Install a 1,000 PSI gauge onto the charge pressure quick disconnect fitting.
4. Start the engine and position throttle at high idle (3000 RPM).

TESTER READING TO BE  $100^{+25}_{-10}$  PSI.

5. If pressure is low, inspect charge relief valve and valve seat.

6. Also take a gauge reading while operating the machine in forward and reverse. Start the engine and put the throttle at full engine RPM. Apply the brakes and push the traction pedal forward, then reverse. If pressure is good under no load, but drops below specification when under traction load, the piston pump and/or motor should be suspected of wear and inefficiency. When the pump and/or motor is worn or damaged the charge pump may not be able to keep up with the internal leakage.

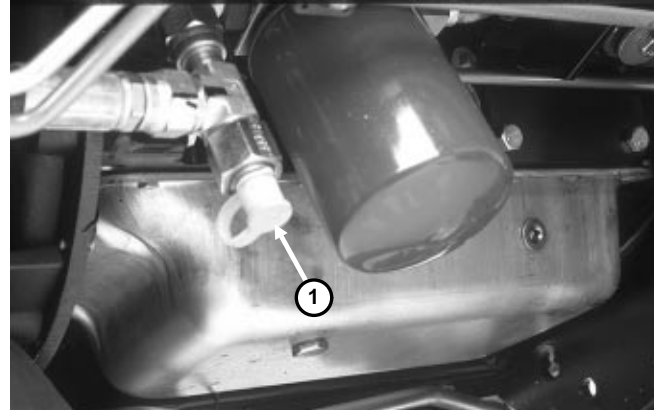


Figure 15

1. Charge pressure test port

# Adjustments

## Traction Pump Neutral Adjustment

The machine must not “creep” when traction pedal is released. If it does creep, an adjustment is required.

1. Park machine on a level surface and shut engine off. Make sure transaxle is engaged in HI position. Depress only the left brake pedal and engage the parking brake.
2. Jack up right side of machine until front tire is off the shop floor. Support machine with jack stands to prevent it from falling accidentally.
3. Under left side of machine, loosen locknut on traction adjustment cam.



### WARNING

**Engine must be running so final adjustment of traction adjustment cam can be performed. To guard against possible personal injury, keep hands, feet, face and other parts of body away from rotating parts.**

4. Start engine and run at low idle.
5. Rotate cam hex in either direction until raised wheel is not rotating.
6. Tighten locknut to secure adjustment.
7. Stop the engine. Remove jack stands and lower machine to ground. Release parking brake and test drive machine to make sure it does not creep in neutral.

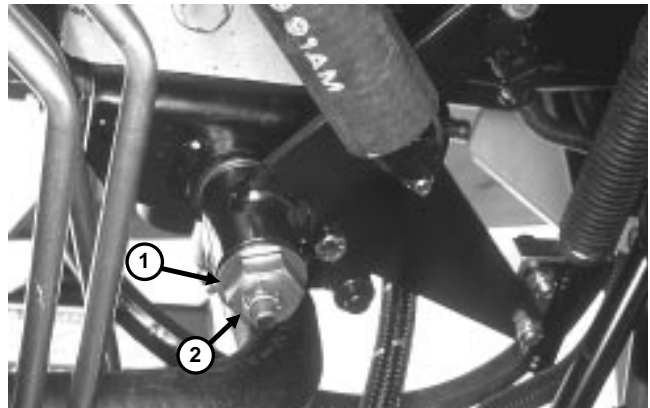


Figure 16

1. Traction adjustment cam
2. Locknut

# Repairs

---

## Removing Hydraulic System Components

1. Thoroughly clean the machine before disconnecting, removing or disassembling any hydraulic components. Always keep in mind the need for cleanliness when working on hydraulic equipment.
2. Put caps or plugs on any hydraulic lines or fittings left open or exposed.
3. Put labels on disconnected hydraulic lines and hoses for proper installation after repairs are completed.

## After Repair or Replacement of Components

1. Check oil level in hydraulic reservoir and add correct oil if necessary. Drain and refill hydraulic system reservoir and change oil filter if component failure was severe or system is contaminated.
2. After repairs, check control linkage for proper adjustment, binding or broken parts.

3. If a pump was disconnected or removed, prime system before operating. Disconnect fuel stop solenoid electrical connector on engine to prevent fuel delivery to engine cylinders. Turn ignition switch to engage starter for ten (10) seconds to prime pumps. Repeat cranking procedure again. Connect injection pump fuel stop solenoid electrical connector. Start engine and run at idle speed for a minimum of two (2) minutes.

4. After disconnecting or replacing any hydraulic components, operate machine functions slowly until air is out of system.

5. Check for hydraulic oil leaks. Shut off engine and correct leaks if necessary. Check oil level in hydraulic reservoir and add correct oil if necessary.

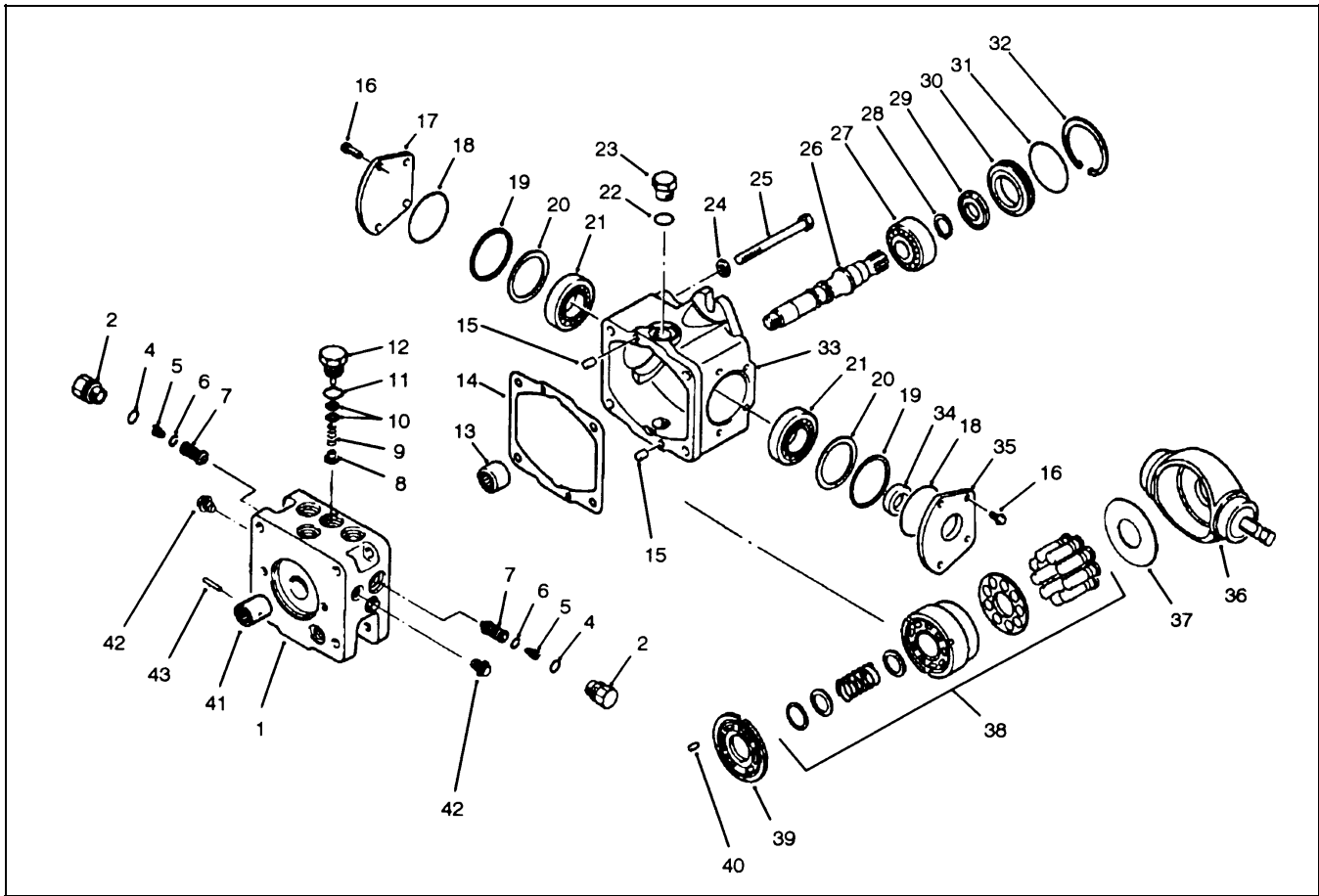


Figure 17

11. Slide seal carrier assembly over shaft and into housing bore. Hold inward pressure against shaft to compress cylinder block spring while pressing seal carrier into position. Install retaining ring.

## Traction Pump Trunnion Seal Replacement (Fig. 18)

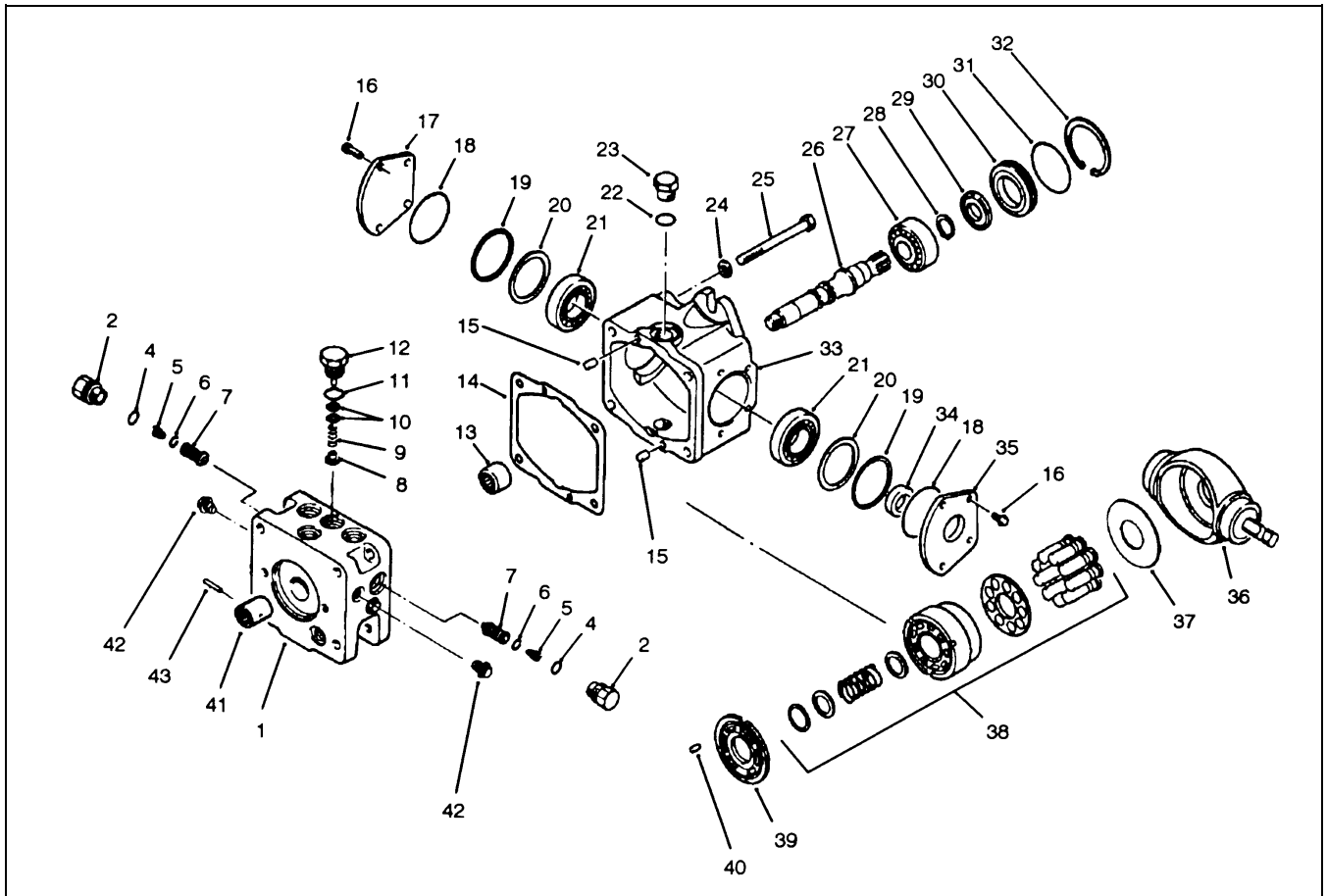


Figure 18

1. Park the machine on a level surface, lower cutting units, engage parking brake and stop the engine.
2. Remove control linkage from swashplate control shaft on transmission (see Transmission Control Removal).
3. Remove hex tapping screws (Item 16) retaining trunnion seal cover (Item 35) to transmission housing.
4. Remove trunnion seal cover with lip seal (Item 34) and o-ring (Item 18).
5. Put seal cover in an arbor press and press out old seal. Once removed, the seal is not reusable.
6. Inspect seal cover for damage. Inspect sealing area on shaft for rust, wear, or contamination. Polish sealing area on shaft if necessary.
7. Using an arbor press, press seal into position from inside of seal cover until it bottoms out in its bore. Be careful not to damage the seal.
8. Install o-ring onto seal cover and retain with petroleum jelly.
9. Use a seal installer tool or wrap end of swashplate control shaft with thin plastic to prevent damage to seal during installation.
10. Slide seal cover assembly over swashplate control shaft onto housing. Install hex tapping screws and tighten to a torque of 6 to 9 ft-lbs.
11. Install control linkage onto transmission. Check machine for "creeping" when engine is running with foot pedal in neutral position. Do Traction Control Neutral Adjustment if necessary.

## Traction Pump Check and High Pressure Relief Valves (Fig. 19)

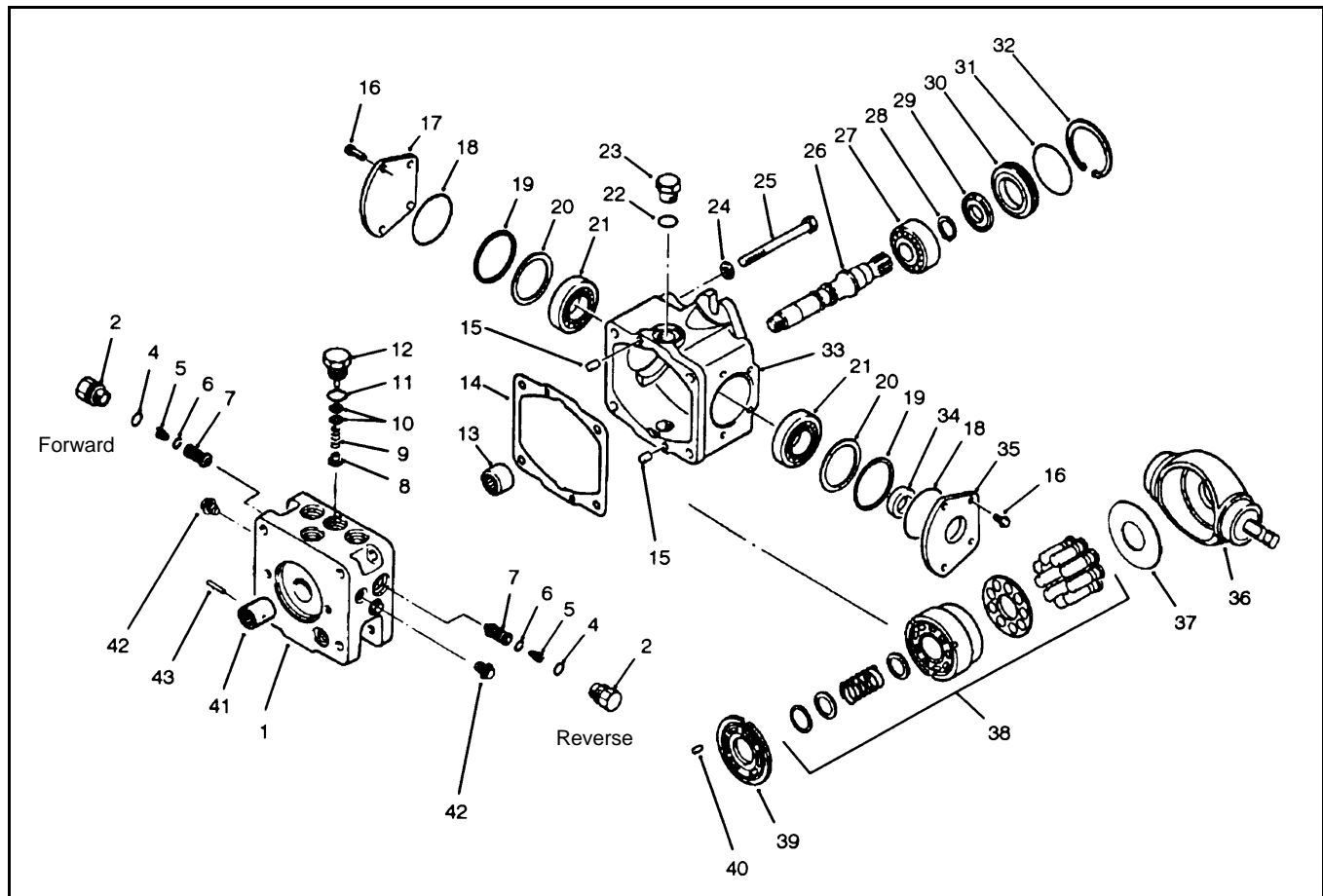


Figure 19

1. Park the machine on a level surface, lower cutting units, engage parking brake and stop the engine.

2. Remove the check/high pressure relief valve hex plug (Item 2).

3. Remove the valve cartridge assembly (Item 7). Inspect the valve and mating seat in the housing for damage or foreign material. It will be necessary to replace the center section if the seat is damaged.

**IMPORTANT: The relief valves are factory set and should not be tampered with, except to replace the entire valve cartridge.**

4. The valve cartridge is retained in the special plug by a circlip (Item 6). The check valve spring (Item 5) may

be removed from the special plug by pulling out at a slight angle. When reassembling, install the check valve spring into the special plug with its larger diameter toward the plug, and snap the valve cartridge into position in the plug.

5. Reinstall the valve cartridges with o-rings into the housing and tighten the plugs to a torque of 30 to 50 ft-lb.

6. Before starting the engine check the oil level in the differential housing and add the correct oil as necessary. Start the engine and let it run for one to two minutes, then turn the engine off and check the oil level again. Check the transmission for leaks.

## Traction Pump Charge Pressure Relief Valve (Fig. 20)

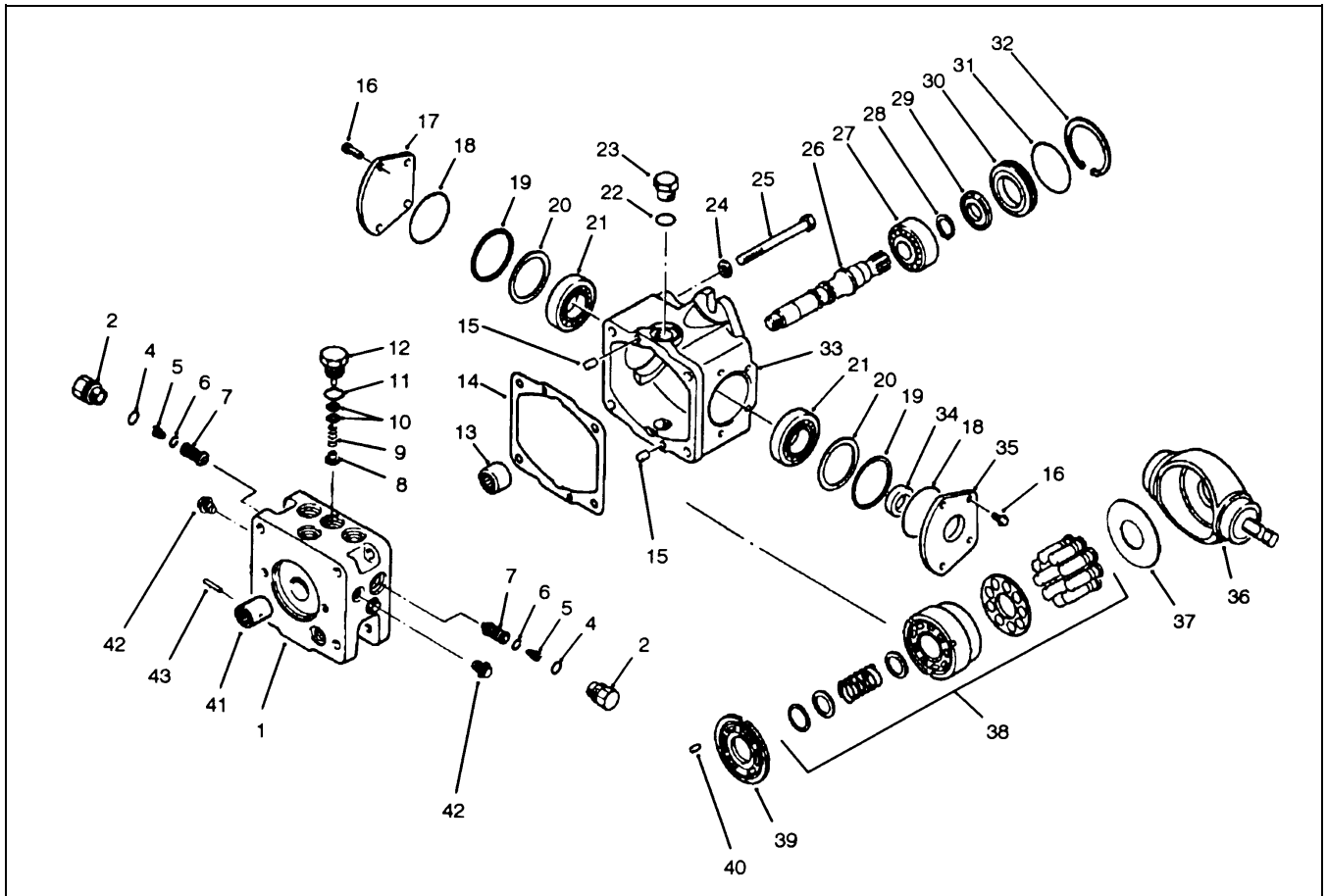


Figure 20

1. Park the machine on a level surface, lower cutting units, engage parking brake and stop the engine.

2. Remove the charge relief valve hex plug (Item 12).

3. Remove the spring (Item 9) and poppet (Item 8) from the housing.

4. Do not interchange parts with another valve.

NOTE: The shim(s) (Item 10) which may be installed between the spring and plug may remain inside the plug, being held by an oil film. Make sure the same number and thickness of shims is installed when reassembling

the parts unless shims need to be added or removed to adjust the pressure setting.

5. Inspect the poppet and mating seat in the end cap for damage or foreign material.

6. Reinstall the poppet, spring and plug (with shims and o-ring) into the housing. Tighten the plug to a torque of 30 to 70 ft-lb.

7. Before starting the engine check the oil level in the differential housing and add the correct oil as necessary. Start the engine and let it run for one to two minutes, then turn the engine off and check the oil level again. Check the transmission for leaks.

## Disassembly of Traction Pump (Fig. 21)

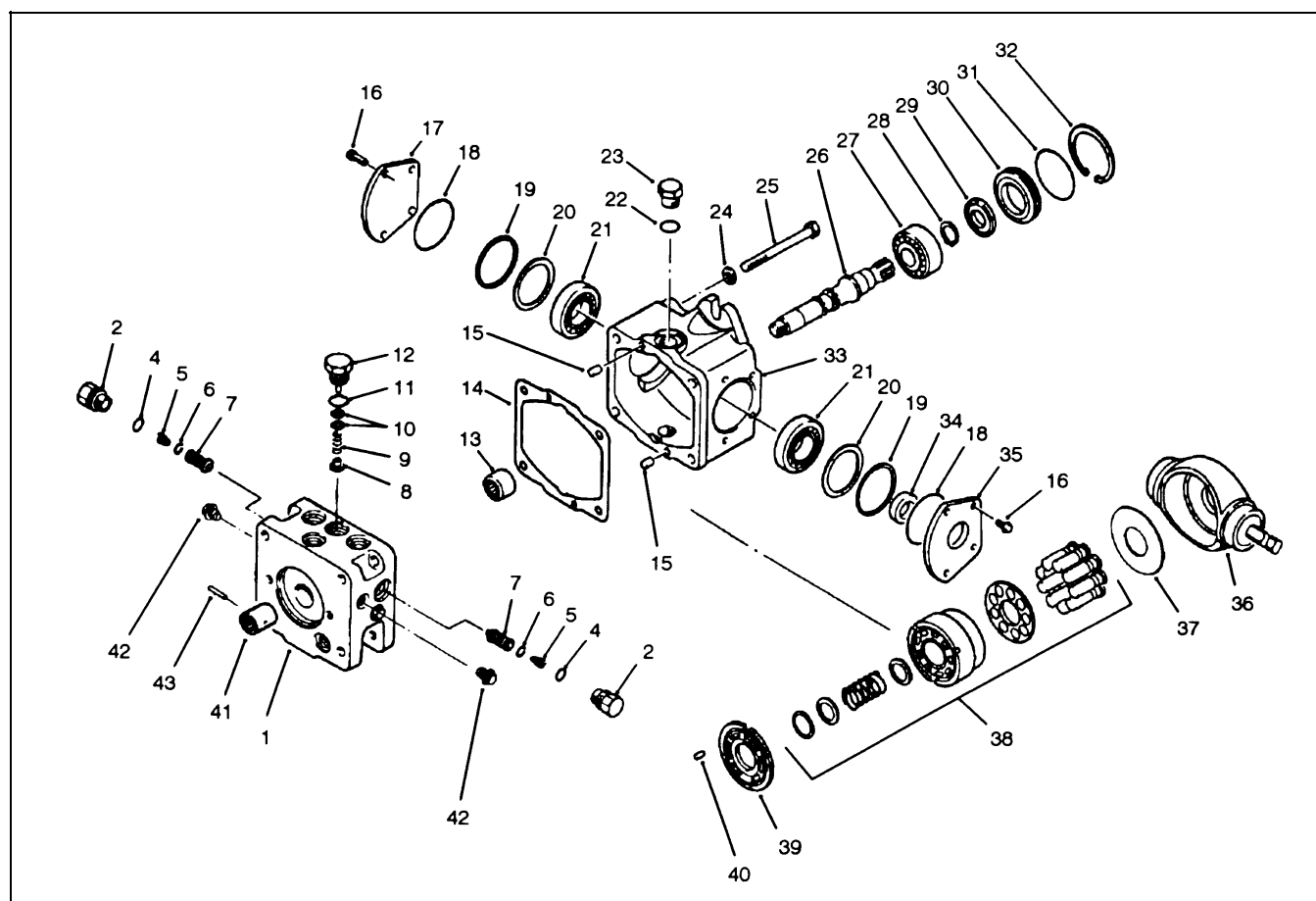


Figure 21

- |                         |                     |                    |
|-------------------------|---------------------|--------------------|
| 1. End cap              | 16. Screw           | 30. Seal carrier   |
| 2. Plug                 | 17. Trunnion cover  | 31. O-ring         |
| 3.                      | 18. O-ring          | 32. Retaining ring |
| 4. O-ring               | 19. Trunnion spacer | 33. Pump housing   |
| 5. Conical spring       | 20. Shim            | 34. Lip seal       |
| 6. Retaining ring       | 21. Roller bearing  | 35. Trunnion cover |
| 7. Relief valve         | 22. O-ring          | 36. Swash plate    |
| 8. Charge relief poppet | 23. O-ring          | 37. Thrust plate   |
| 9. Spring               | 24. Washer          | 38. Cylinder block |
| 10. Shim                | 25. Capscrew        | 39. Valve plate    |
| 11. O-ring              | 26. Pump shaft      | 40. Pin            |
| 12. Charge relief plug  | 27. Ball bearing    | 41. Coupling       |
| 13. Needle bearing      | 28. Retaining ring  | 42. Plug           |
| 14. End cap gasket      | 29. Lip seal        | 43. Pin            |
| 15. Pin                 | 30. Seal carrier    |                    |

Clean parts by using a clean solvent wash and air drying. Keep parts free of foreign materials and chemicals. Protect all sealing surfaces and open cavities from damage and foreign material.

During assembly of the pump, all surfaces which have relative motion between two parts should be coated with a film of clean hydraulic oil. This will assure that these surfaces will be lubricated during start-up.

It is recommended that all gaskets, o-rings and seals be replaced. Lightly lubricate all o-rings with clean petro-

leum jelly before assembly. All gasket sealing surfaces must be cleaned before installing new gaskets.

1. Before performing major repairs on the pump, remove external components as described in previous procedures. These include the Charge Check / High Pressure Relief Valves and Charge Relief Valve.

2. Remove pin (Item 43) from coupling (Item 41) on output end of pump shaft. Remove the coupling.

3. Remove four (4) screws (Item 25) which retain end cap to pump housing.



4. Remove end cap (Item 1) from pump housing.

**IMPORTANT: The valve plate (Item 39) may stick to the end cap. Do not allow valve plate to fall from end cap.**

5. Remove gasket (Item 14) and alignment pins (Item 15) from end cap.

**IMPORTANT: Be careful not to damage valve plate and end cap surfaces.**

6. Carefully remove valve plate (Item 39) from end cap. It may be necessary to pry valve plate off with a small screwdriver.

7. Remove valve plate pins (Item 40) from end cap.

8. Lay pump housing on its side and remove cylinder block assembly (Item 38) from housing.

9. Remove the slipper guide and piston assemblies from cylinder block.

10. Use an o-ring pick or wire to remove thrust plate (Item 37) from swashplate and housing.

11. Remove shaft seal carrier. (See Tandem Pump Shaft Seal Replacement.)

12. Slide drive shaft (Item 26) and bearing assembly (Item 27) from housing.

13. Remove retaining ring (Item 28) and press shaft out of bearing.

14. Remove hex tapping screws (Item 16) retaining trunnion seal cover (Item 35) and trunnion cover (Item 17) to housing. Mark position of covers for reassembly.

15. The trunnion seal cover assembly includes an o-ring (Item 18) and lip seal (Item 34) on the control side and

an o-ring (Item 18), on the side opposite the control. Remove these parts from the housing. (See Trunnion Seal Replacement).

16. Remove the trunnion spacers (Item 19), shims (Item 20) and roller bearings (Item 21) from housing and swashplate. The bearing assemblies are a slip fit in the housing.

17. Tilt and lift swashplate (Item 36) from housing.

### Inspection and Replacement of Parts

18. After disassembly, thoroughly clean all parts in a suitable solvent. Replace all o-rings, gaskets and seals.

19. Inspect all parts for damage, nicks or unusual wear patterns. Replace all parts having unusual or excessive wear or discoloration.

20. If scratches, which can be felt with a pencil lead, can be found on bronze surface of valve plates or running surface of cylinder blocks, polish or replace the parts.

21. Inspect needle bearings and drive coupling in center section. If replacement is necessary, remove shaft needle bearings using a suitable puller. Do not damage valve plate surface of center section.

22. Press new needle bearing (Item 13) into end cap using a suitable press pin. When installed correctly, bearing cage will protrude from 0.08 to 0.10 in. from surface of end cap to serve as pilot for valve plate.

**IMPORTANT: When installing the needle bearing, the printed (numbered) end of the bearing cage must face the press pin.**

23. Install a new cylinder block kit if brass slippers on pistons are scored or excessively rounded at edges.

## Assembly of Traction Pump (Fig. 22)

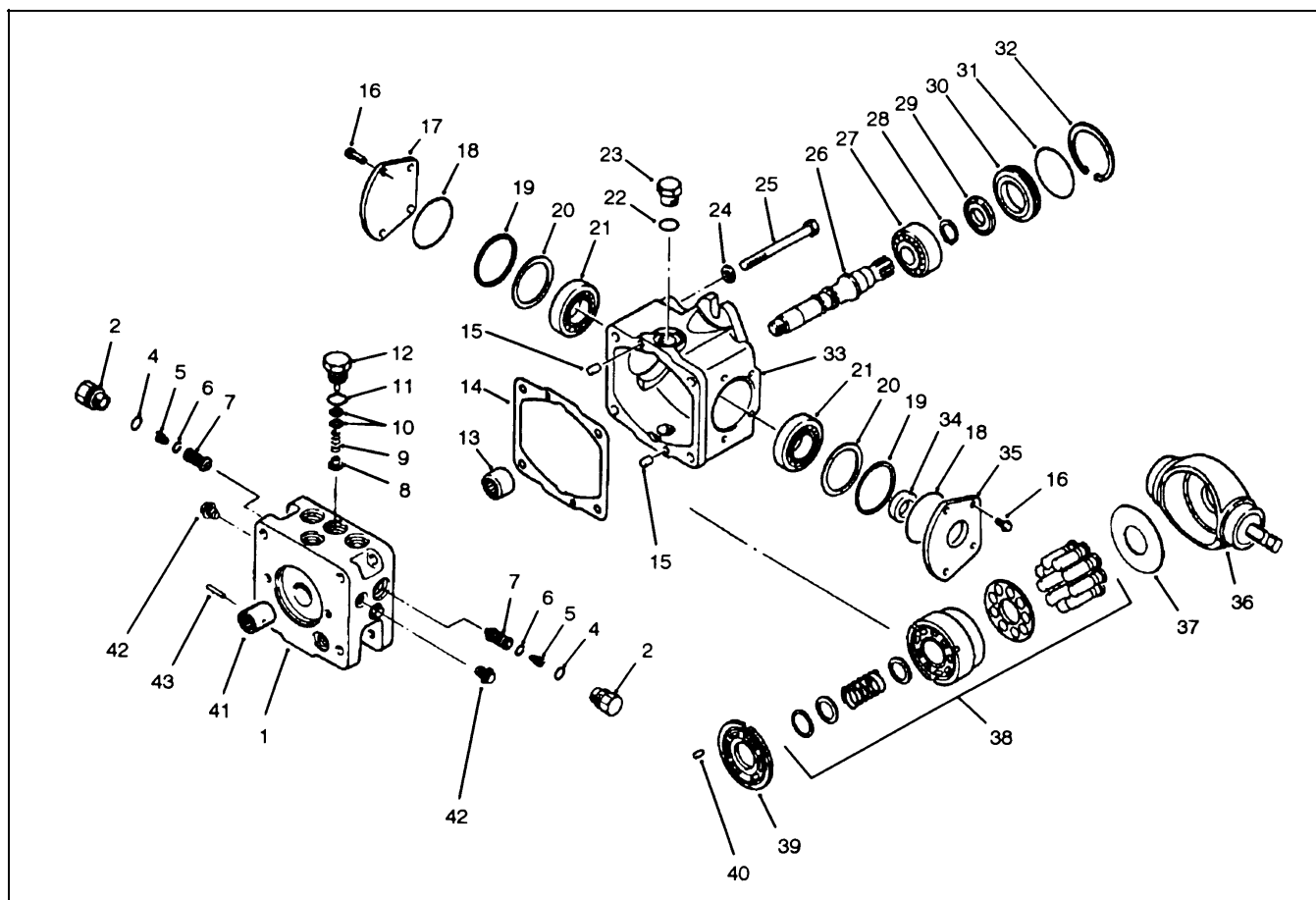


Figure 22

- |                         |                     |                    |
|-------------------------|---------------------|--------------------|
| 1. End cap              | 16. Screw           | 30. Seal carrier   |
| 2. Plug                 | 17. Trunnion cover  | 31. O-ring         |
| 3.                      | 18. O-ring          | 32. Retaining ring |
| 4. O-ring               | 19. Trunnion spacer | 33. Pump housing   |
| 5. Conical spring       | 20. Shim            | 34. Lip seal       |
| 6. Retaining ring       | 21. Roller bearing  | 35. Trunnion cover |
| 7. Relief valve         | 22. O-ring          | 36. Swash plate    |
| 8. Charge relief poppet | 23. O-ring          | 37. Thrust plate   |
| 9. Spring               | 24. Washer          | 38. Cylinder block |
| 10. Shim                | 25. Capscrew        | 39. Valve plate    |
| 11. O-ring              | 26. Pump shaft      | 40. Pin            |
| 12. Charge relief plug  | 27. Ball bearing    | 41. Coupling       |
| 13. Needle bearing      | 28. Retaining ring  | 42. Plug           |
| 14. End cap gasket      | 29. Lip seal        | 43. Pin            |
| 15. Pin                 | 30. Seal carrier    |                    |

1. Clean and lightly oil parts before assembly. Tighten all threaded parts to recommended torque value.

**IMPORTANT: Most parts have critical, high tolerance surfaces. Use caution to prevent damage to these surfaces during assembly. Protect exposed surfaces, openings and ports from damage and foreign material.**

2. Install swashplate (Item 36) into housing. Make sure swashplate control shaft is located on correct side of housing (note marks made during disassembly). Install

swashplate roller bearings (Item 21) into housing and onto swashplate trunnions. Install shims (Item 20) and trunnion spacers (Item 19).

3. Install trunnion cover (Item 17) with o-ring (Item 18) onto housing and over swashplate trunnion.

4. Use an arbor press to press a new seal (Item 34) into trunnion seal cover (Item 35). Outer face of seal should be pressed flush with outer surface of seal cover. Be careful not to damage the seal.

5. Install trunnion seal cover (Item 35) with o-ring (Item 18), seal (Item 34) and trunnion bearing into housing and over swashplate trunnion (see Trunnion Seal Replacement). Wrap end of swashplate control shaft with thin plastic to prevent damage to seal lip during installation.

6. Install hex tapping screws (Item 16) and tighten to a torque of 6 to 9 ft-lb.

7. Using caution to not damage the sealing surface, press ball bearing (Item 27) onto drive shaft (Item 26). Install bearing retaining ring (Item 28) onto shaft.

8. Install drive shaft and bearing into housing.

9. Install input shaft seal (Item 29), seal carrier (Item 30) and o-ring (Item 31) as described in Traction Pump Shaft Seal Replacement. Coat thrust plate (Item 37) with petroleum jelly and install onto swashplate (Item 36). The thrust plate is reversible.

10. Assemble cylinder block kit (Item 38) by installing piston assemblies into the slipper guide. Lubricate pistons and cylinder block bores. Install assembled guide and pistons into cylinder block by inserting pistons into cylinder block bores. The pistons and bores are not selectively fitted, so no specific piston and bore orientation is required.

11. Lay the pump on its side and install cylinder block kit into the housing.

12. Install valve plate locating pins (Item 40) into end cap.

13. Coat back (steel side) of valve plate (Item 39) with petroleum jelly to hold it in position and install valve plate onto end cap (Item 1), with the bronze face visible. The notch on the valve plate must engage the locating pin.

14. Install the two (2) alignment pins (Item 15) and install new gasket (Item 14) onto end cap.

15. Assemble end cap (with valve plate installed onto pump housing. When properly assembled, cylinder block spring will hold end cap away from housing approximately 1/8 in.

16. Install the four (4) screws (Item 25) and washers (Item 24) that retain housing to end cap and evenly tighten to a torque of 45 to 54 ft-lb.

**IMPORTANT: Be sure all parts are properly aligned. Do not force end cap into position on housing.**

17. Rotate the pump shaft to make sure pump is assembled correctly. When properly assembled, a maximum torque of 7 ft-lb should be required to turn shaft.

18. Install coupling (Item 41) to output end of pump shaft and secure in place with the pin (Item 43).

19. Assemble the following components as described in previous procedures:

Charge Check / High Pressure Relief Valves  
Charge Relief Valve

## Auxiliary/Steering Pump No. 92-7761 (S/N 69999 and Below) (Fig. 23)

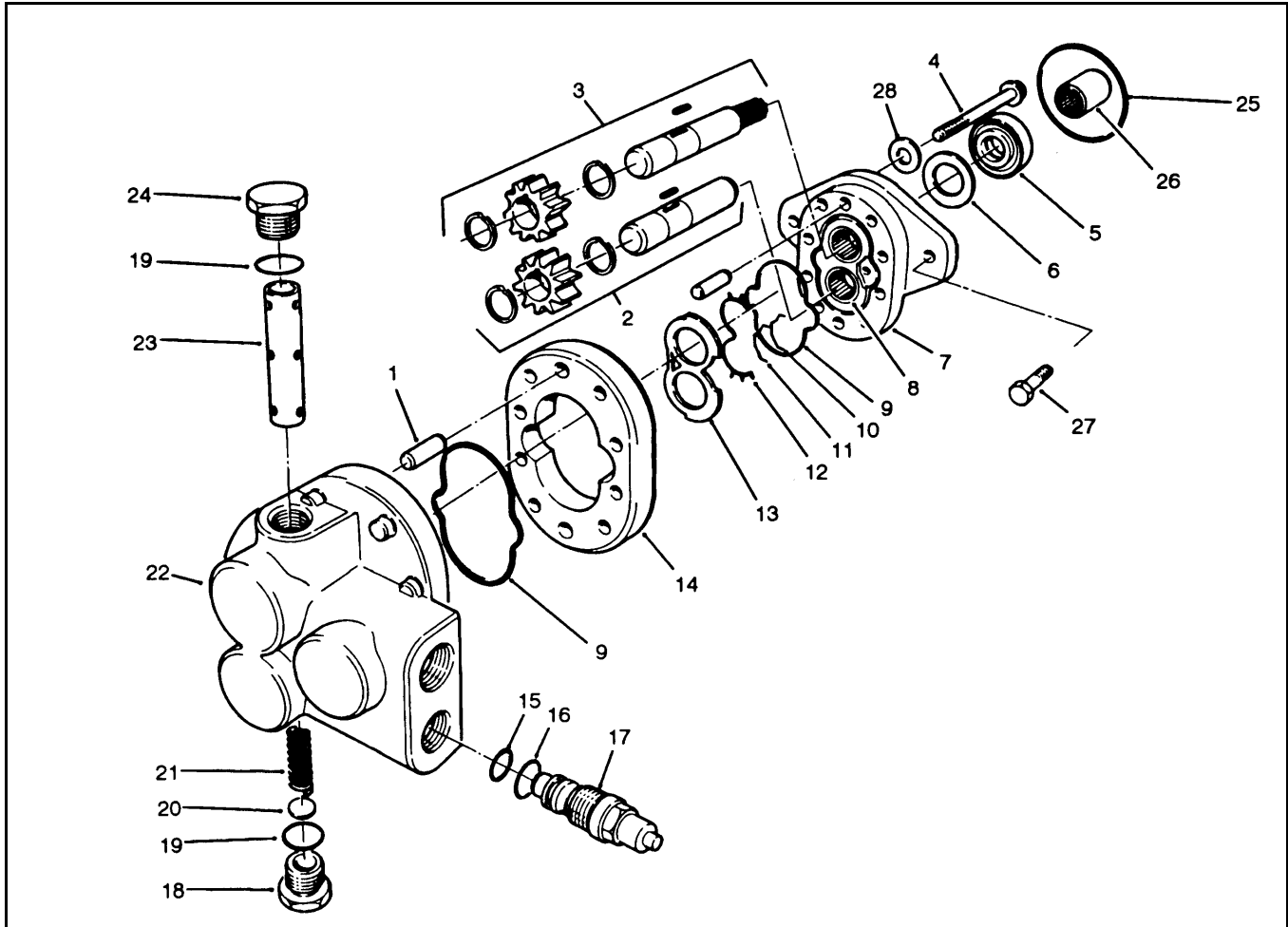


Figure 23

- |                           |                           |                         |
|---------------------------|---------------------------|-------------------------|
| 1. Dowel pin              | 11. Bearing seal          | 21. Spring              |
| 2. Idler gear assembly    | 12. Backup gasket         | 22. Back plate assembly |
| 3. Drive gear assembly    | 13. Wear plate            | 23. Spool assembly      |
| 4. Capscrew               | 14. Body assembly         | 24. Plug assembly       |
| 5. Shaft seal             | 15. O-ring seal           | 25. O-ring              |
| 6. Washer                 | 16. O-ring seal           | 27. Coupling            |
| 7. Front plate assembly   | 17. Relief valve assembly | 28. Hex capscrew        |
| 8. Needle bearing         | 18. Plug assembly         |                         |
| 9. O-ring seal            | 19. O-ring                |                         |
| 10. O-ring seal (moulded) | 20. Disc                  |                         |

### Disassembly of Auxiliary/Steering Pump

1. Thoroughly clean outside of pump.
2. Use a sharp tool or marker to mark across front plate (Item 7), body (Item 14) and back plate (Item 22). This will assure proper reassembly.
3. Clamp pump in a vise, with the shaft up.
4. Remove capscrews (Item 28).
5. Remove pump from vise, hold pump in hands and bump shaft against a wood block to separate front plate (Item 7) from back plate (Item 22). Body (Item 14) will remain with either front plate or back plate.
6. If front plate was removed first, remove wear plate (Item 13) from body gear pockets.
7. Remove drive gear assembly (Item 3) and idler gear assembly (Item 2) from body.
8. To separate body (Item 14) from plate it remains with, put drive gear assembly (Item 3) in a bushing and tap protruding end with a plastic hammer or soft mallet.
9. Remove o-ring (Item 9) from front plate and back plate.

10. Remove backup-up gasket (Item 12) from front plate.

11. Remove bearing seal (Item 11) from front plate by prying with a sharp tool.

12. Remove molded o-ring (Item 10) from front plate by prying with a screwdriver.

13. Remove shaft seal (Item 5) from front plate by prying with a screwdriver.

### **Disassembly of Back Plate Assembly (Flow Divider / Flow Control / Relief Valve)**

1. Remove relief valve (Item 17) from back plate.

NOTE: Do not disassemble relief valve cartridge assembly – it must be replaced as an assembly.

2. Remove hex plugs (Item 24, 18) flow divider spool (Item 23), spring (Item 21) and disk (Item 20).

### **Inspect Auxiliary/Steering Pump Parts**

#### **GENERAL**

1. Clean and dry all parts.

2. Remove all nicks and burrs from all parts with emery cloth.

#### **GEAR ASSEMBLY (Item 2, 3)**

1. Check drive shaft spline for twisted or broken teeth.

2. Inspect both drive gear and idler gear shafts at bushing points and seal area for rough surfaces and excessive wear.

3. If shaft measures less than 0.748" in bushing area, the gear assembly should be replaced (one gear assembly may be replaced separately; shafts and gears are available as assemblies only).

4. Inspect gear face for scoring and excessive wear.

5. If gear width is less than 0.636", the gear assembly should be replaced.

6. Be sure snap rings are in grooves on either side of drive and idler gears.

7. If edge of gear teeth are sharp, break edge with emery cloth.

#### **FRONT PLATE (Item 7) AND BACK PLATE (Item 22)**

1. Oil groove in bushings in both front plate and back plate should be in line with dowel pin holes and 180 apart.

2. If I.D. of bushings in front plate or back plate exceed 0.755", front or back plate should be replaced (bushings are not available separately).

3. Bushings in front plate should be flush with face of front plate.

4. Check for scoring on face of back plate. If wear exceeds 0.0015", back plate should be replaced.

#### **BODY (Item 14)**

1. Check inside gear pockets for excessive scoring or wear.

2. Body should be replaced if I.D. of gear pocket exceeds 1.713".

#### **FLOW DIVIDER / FLOW CONTROL / RELIEF VALVE**

1. Check disk (Item 20) for wear.

2. Check spring (Item 21) for weakness or breakage.

3. Wash back plate in clean solvent, then direct compressed air into relief valve and flow divider cavities in back plate to remove any contamination.

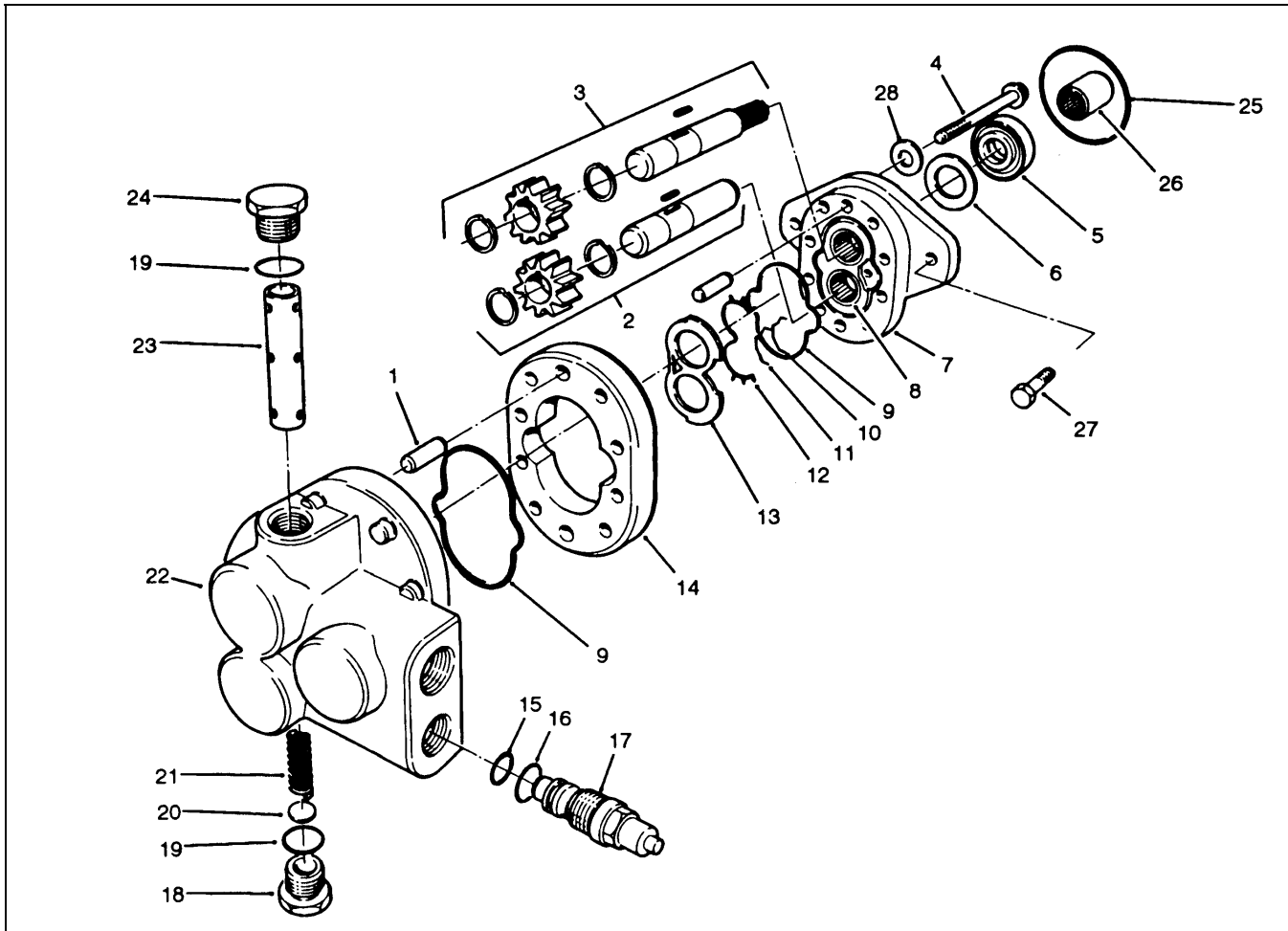


Figure 23

### General Auxiliary/Steering Pump Information

It is important that the relationship of the back plate (Item 22), body (Item 14), wear plate (Item 13) and front plate (Item 7) is correct. You will note two half moon cavities in the body which must face away from the front plate. NOTE: The smaller half moon port cavity must be on the pressure side of the pump. Side of wear plate with mid section cut out must be on suction side of pump. Suction side of back plate is always side with larger port boss.

### Assembly of Back Plate Parts

1. Install relief valve (Item 17) with new o-rings (Item 15, 16).
2. Install flow divider spool (Item 23), plug (Item 24) with new o-ring (Item 19), spring (Item 21), disk (Item 20) and other plug (Item 18) with new o-ring (Item 19).

### Assembly of Auxiliary/Steering Pump

1. The wear plate (Item 13), bearing seal (Item 11), molded o-ring (Item 10), back-up gasket (Item 12), shaft seal (Item 5) and o-rings (Item 9) should be replaced as new parts.

2. Install o-ring (Item 9) in groove of front plate (Item 7).

3. Tuck back-up gasket (Item 12) into groove in front plate with open part of "V" section down.

4. Put molded o-ring (Item 10) in groove in front plate. Put bearing seal (Item 11) over molded o-ring - groove side down.

5. Apply a thin coat of heavy grease to both milled faces of body (Item 14). Slip body onto front plate - half moon port cavities in body must face away from front plate.

NOTE: The small half moon port cavity must be on the pressure side of the pump.

6. Put wear plate (Item 13) on top of back-up gasket with bronze face up. The side with the mid section cut away must be on suction side of pump.

7. Dip gear assemblies (Item 2, 3) into oil and slip into front plate bushings.

8. Install o-ring (Item 9) in groove in back plate (Item 22).

9. Slide back plate over gear shafts until dowel pins (Item 1) are engaged.

10. Install bolts (Item 4) and washers (Item 28). Tighten evenly to a torque of 25 - 28 ft-lb.

11. Install washer (Item 6). Liberally oil shaft seal (Item 5) and carefully work over drive shaft, being careful not to cut rubber sealing lip.

12. Put a 1-5/16" O.D. sleeve over the shaft and press in shaft seal until flush with front surface of front plate.

## Gear Pump No. 94-8297 (S/N 70001 & Up) (Fig. 23a)

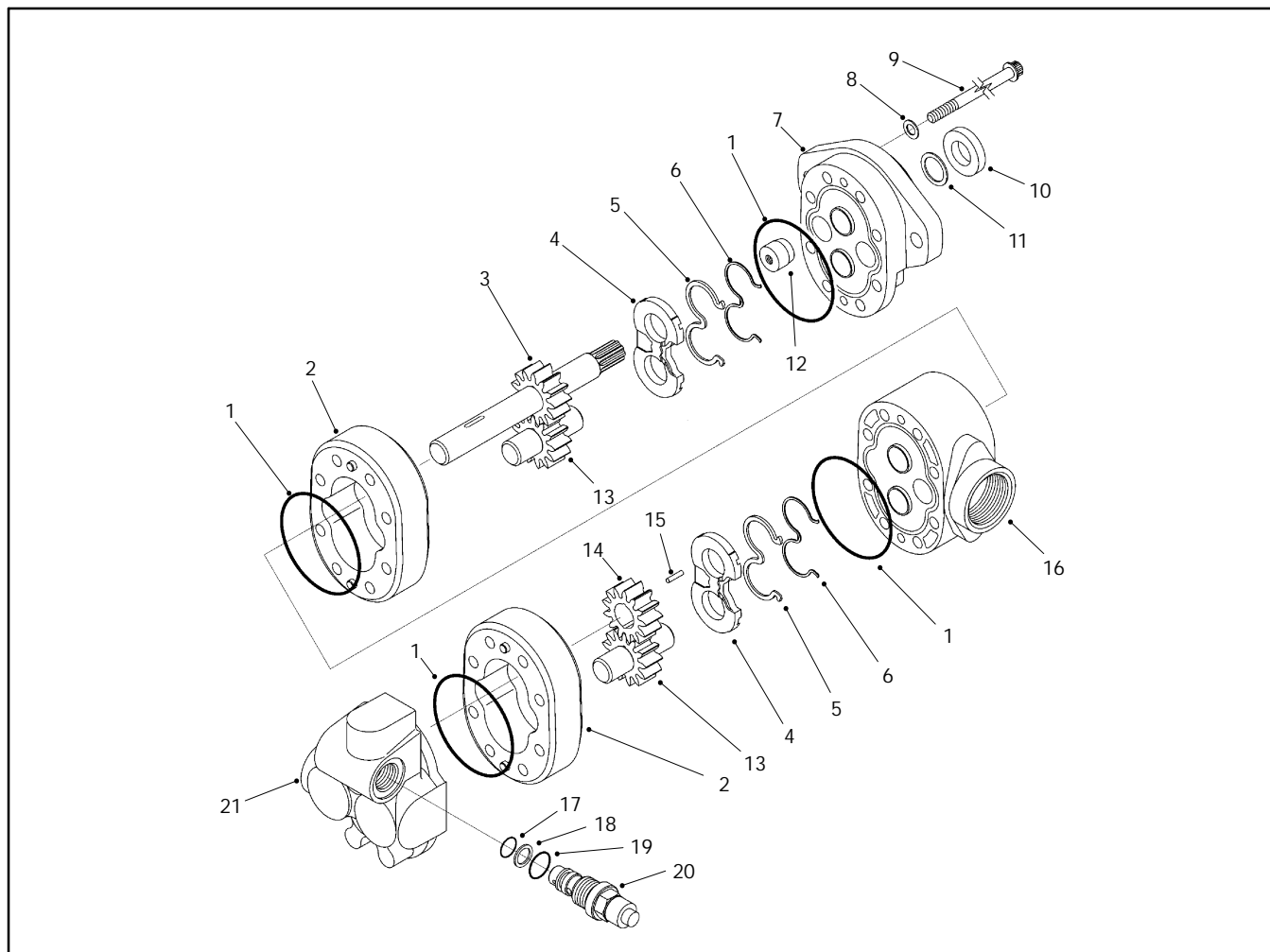


Figure 23a

- 1. O-ring
- 2. Body asm.
- 3. Drive gear asm.
- 4. Wear plate
- 5. Backup gasket
- 6. Seal
- 7. Front plate

- 8. Washer
- 9. Cap screw
- 10. Shaft seal
- 11. Washer
- 12. Plug
- 13. Idler gear
- 14. Gear

- 15. Key
- 16. Adaptor plate
- 17. O-ring
- 18. Washer
- 19. O-ring
- 20. Valve
- 21. Back plate asm.



## Repair Information

Work in a clean area, cleanliness is extremely important when repairing hydraulic pumps. Before disconnecting the lines, clean port area of pump. Disconnect hydraulic lines, removing pump assembly from vehicle and plug ports. Thoroughly clean the outside of pump. After cleaning then remove port plugs and drain oil.

## Disassembly

1. Scribe a line, at an angle, across front plate (7), bodies (2), adapter plate (16) and backplate (21). This will assure proper reassembly.

**NOTE:** To maintain maximum pump efficiency, keep body, gears and wear plates for each section together. DO NOT mix parts between different sections.

2. Clamp pump in vise, shaft end up.

3. Remove the eight cap screws (9).

4. Remove pump from vise, hold pump in hands and bump shaft against wooden block to separate pump sections. Front body (2) will remain with either front plate (7) or adapter plate (16).

5. Place front idler gear (13) back into gear pocket and tap protruding end with soft face hammer to remove front body (2) from the front plate (7) or adaptor plate (16).

6. Remove adapter plate (16) from body (2) by tapping on the adapter plate with a plastic hammer or rawhide mallet.

7. Remove backplate (21) from body (2) by tapping on backplate with plastic hammer or rawhide mallet.

8. Remove rear idler gear (13), slip fit gear (14) and key (15).

9. Remove drive gear assembly (3) from adapter plate (16).

10. Place rear idler gear (13) back into gear pocket and tap protruding end with soft face hammer to remove rear body (2) from the backplate assembly (21) or adaptor plate (16).

11. Remove the wear plates (4) from front plate (7) and adapter plate (16).

12. Remove o-rings (1) from front plate (7), adapter plate (16), and backplate (21).

13. Remove backup gaskets (5) and balance pressure seals (6) from front plate (7) and adapter plate (16) by prying out with a sharp tool.

14. Remove shaft seal (10) and washer (11) from front plate (7) by prying with a screw driver. Be careful not to damage seal bore.

15. Remove relief valve (20) from backplate assembly (21).

16. Remove O-ring (17), backup washer (18), and O-ring (19) from relief valve (20).

## Inspect Parts for Wear General

1. Clean and dry all parts.

2. Remove nicks and burrs from all parts with emery cloth.

## Gear Assembly Inspection

1. Check spline drive shaft for twisted or broken teeth. Also check for damaged keyway, on drive shaft, that drives the slip fit gear of the rear pump.

2. Inspect both the drive gear and idler gear shafts at bushing points and seal area for rough surfaces and excessive wear.

3. Replace gear assembly if shaft is worn in bushing area. (One gear assembly may be replaced separately; shafts and gears are available as assemblies only. The slip fit gear is available separately).

4. Inspect gear face for scoring and excessive wear.

5. Assure that snap rings are in grooves on either side of drive and idler gears.

6. If edge of gear teeth are sharp, break edge with emery cloth.

## **Front Plate, Backplate and Adapter Plates Inspection**

1. Oil groove in bushings in front plate, backplate and adapter plates should be in line with dowel pin holes and 180 degrees apart. This positions the oil grooves closest to respective dowel pin holes.
2. Replace the backplate, front plate or adapter plates if bushings are worn (Bushings are not available as separate items).
3. Bushings in front plate and backup gasket side of adapter plates should be flush with face of plate.
4. Check for scoring on face of backplate or adapter plates.

## **Body Inspection**

1. Check bodies inside gear pockets for excessive scoring or wear.
2. Replace bodies if I.D. of gear pockets is worn.

## **General Information**

It is important that the relationship of the backplate, adapter plates, bodies, wear plate and front plate is correct. You note two half moon cavities in the body which must face away from the front plate or adapter plate. Note: The smaller half moon port cavity must be on the pressure side of the pump. The side of wear plate with mid section cut out must be on suction side of pump. Suction side of backplate or adapter plate is the side with larger port boss.

## **Reassembly**

1. Replace the wear plates (4), seals (6), backup gaskets (5), shaft seal (10) and o-rings (1) as new parts.
2. Install o-rings (1) in groove of front plate (7), adapter plate (16), and backplate (21) with a small amount of petroleum jelly to hold in place.
3. Tuck backup gasket (5) in front plate (7) and adapter plate (16) with open part of "V" section down.

4. Place balance pressure seal (6) in groove in front plate (7) and adapter plate (16).

5. Apply a thin coat of petroleum jelly to both milled gear pockets of front body (2). Slip body onto front plate (7) with half moon port cavities in body facing away from front plate.

NOTE: The small half moon port cavity must be on the pressure side of pump.

6. Place wear plate (4) on top of backup gasket (5) with bronze face up. The side with the mid section cut away must be on suction side of pump.

7. Dip drive gear assembly (3) and idler gear assembly (13) into oil. Slip both gear assemblies into gear pocket of front body (2) and into front plate bushings.

8. Place wear plate (4) on top of backup gasket (5) with bronze face up. The side with the mid section cut away must be on suction side of pump.

9. Install adapter plate (16) in place on front body (2). Check positioning marks.

10. Install rear body (2) onto adapter plate (16).

11. Install key (15) in slot of drive gear shaft (3). Dip slip fit gear (13) in oil and slip on shaft and into gear pocket of rear body (2). Check key for proper alignment.

12. Dip idler gear (13) in oil and install in gear pocket of rear body (2).

13. Position backplate (21) over shafts until dowel pins in body are engaged.

14. Secure with cap screws (9) and washers (8). Tighten cap screws evenly in a crisscross pattern to 25 to 28 ft-lbs. [34 to 38 Nm] torque.

15. Place washer (11) over drive shaft into housing. Liberally oil shaft seal (10) and install over drive shaft carefully so that rubber sealing lips are not cut.

16. Place a sleeve over shaft and press in shaft seal (10) .20 in. (5.08mm) below front surface of front plate.

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## Front Traction Motor Repairs (Fig. 24)

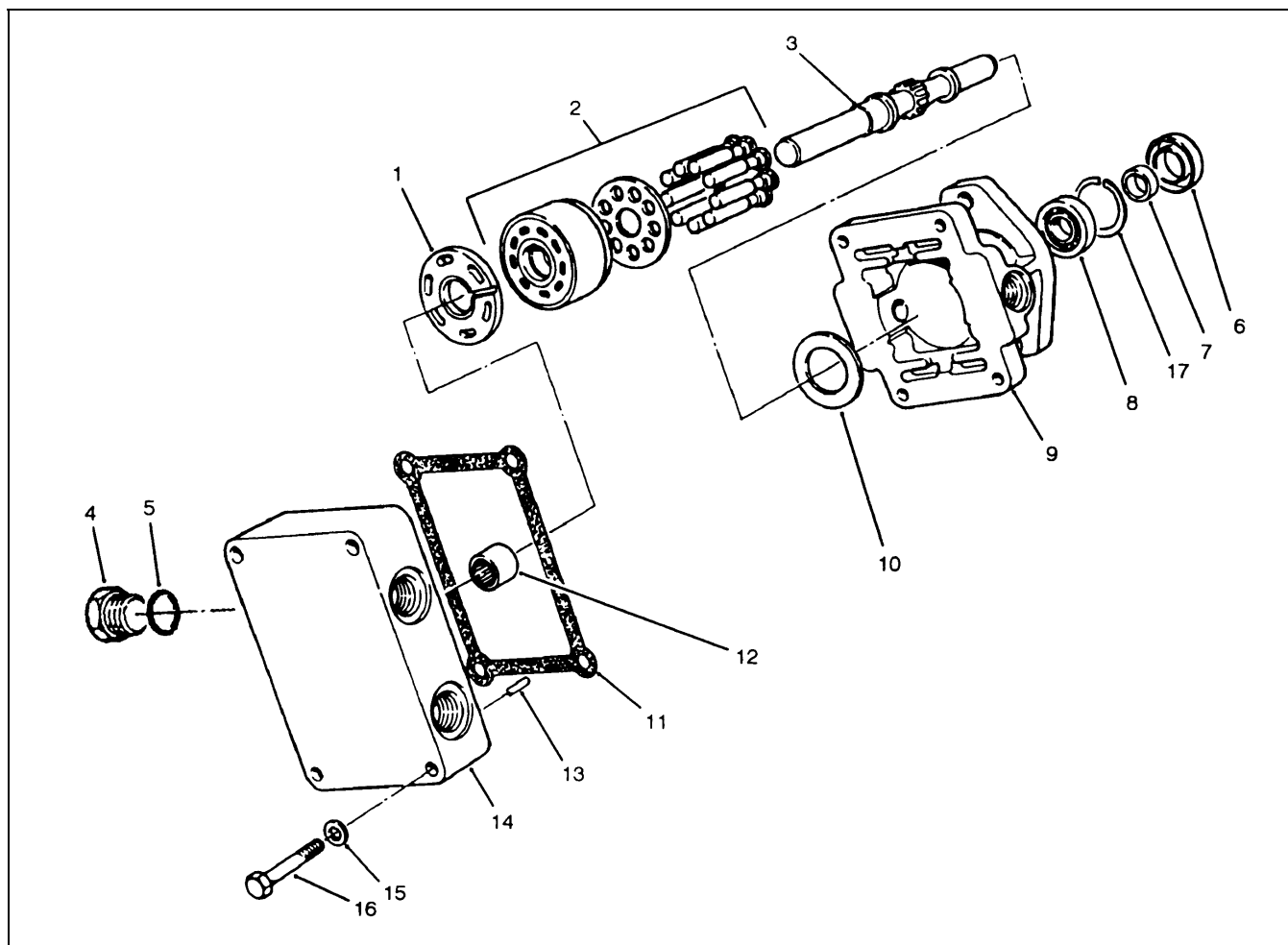


Figure 24

- 1. Valve plate
- 2. Cylinder block kit
- 3. Shaft assembly
- 4. Plug
- 5. O-ring seal
- 6. Lip seal

- 7. Sleeve
- 8. Roller bearing
- 9. Housing
- 10. Thrust plate
- 11. Gasket
- 12. Bearing

- 13. Straight
- 14. End cap assembly
- 15. Flat washer
- 16. Capscrew
- 17. Retaining ring

### Shaft Seal Replacement

The lip type shaft seal (Item 6) can be replaced without disassembly of the motor; however, replacement of the seal requires removal of the motor from the transaxle.

Pry the seal carefully out of the housing bore, using care not to distort the housing or damage the bore or shaft. Once removed, the seal is not reusable.

Prior to installing the new seal, polish the shaft extension, wrap it in thin plastic and lubricate with hydraulic oil to insure that the seal is not damaged during assembly. Slide the seal over the shaft and press it into the housing bore.

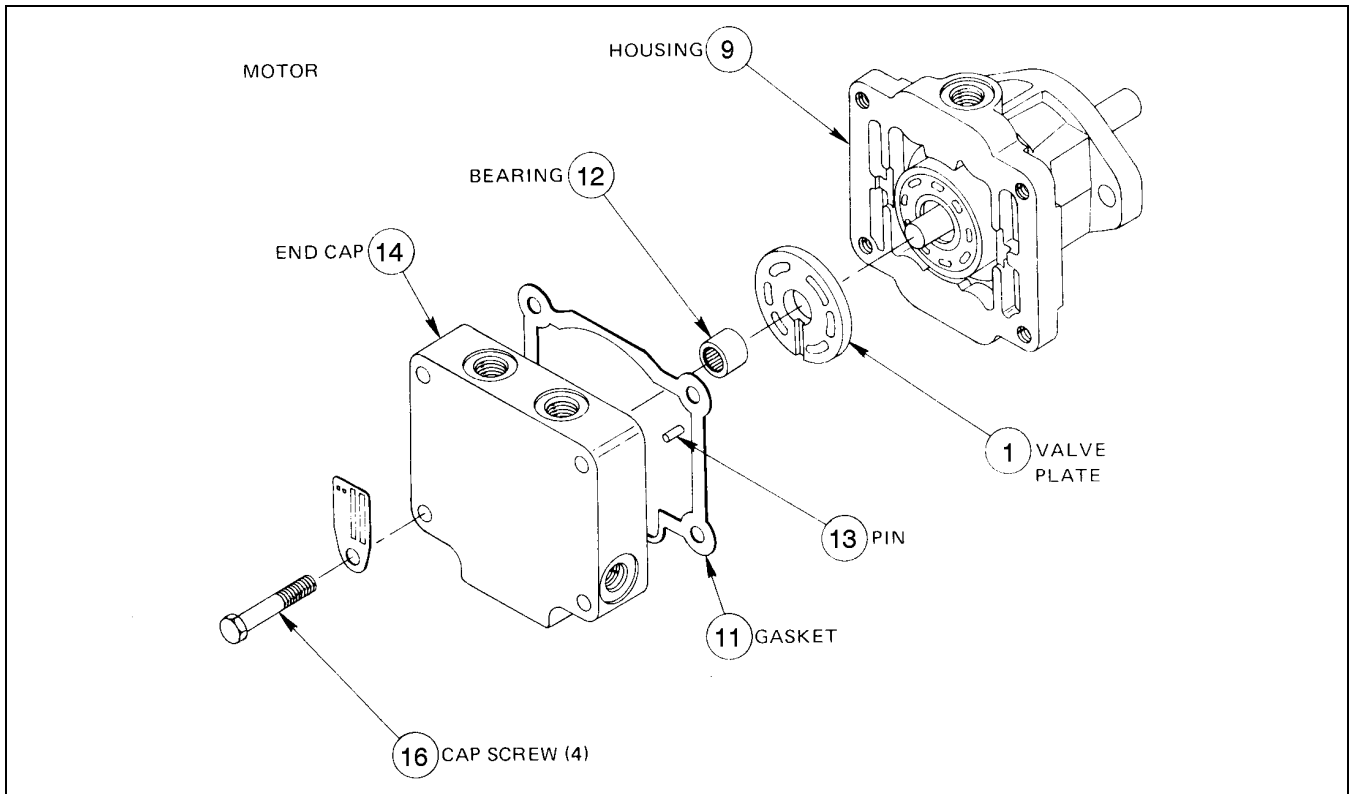


Figure 25

When the four (4) cap screws (Item 16) are loosened, the internal spring loading will cause the end cap (Item 14) to separate slightly. Loosen these screws evenly to prevent distortion of parts. If separation does not occur as screws are loosened, tap end cap with soft hammer until parts separate.

**IMPORTANT: All surfaces exposed are critical and caution must be used to avoid damage.**

Note the orientation of housing (Item 9) to end cap (Item 14). To insure proper assembly scribe a line across housing and end cap for an assembly guide.

The end cap (Item 14) can now be removed from the motor, however, be certain that the valve plate (Item 1) does not fall and become damaged. If the valve plate tends to lift off with the end cap (Item 14), hold it in place on the end cap and remove both parts together. If the valve plate remains on the cylinder block, remove it at this time.

The end cap is actually an assembly consisting of a needle bearing which is a press fit in the end cap and the valve plate locating pin (Item 13). Inspect the bearing (Item 12) and remove if replacement is required.

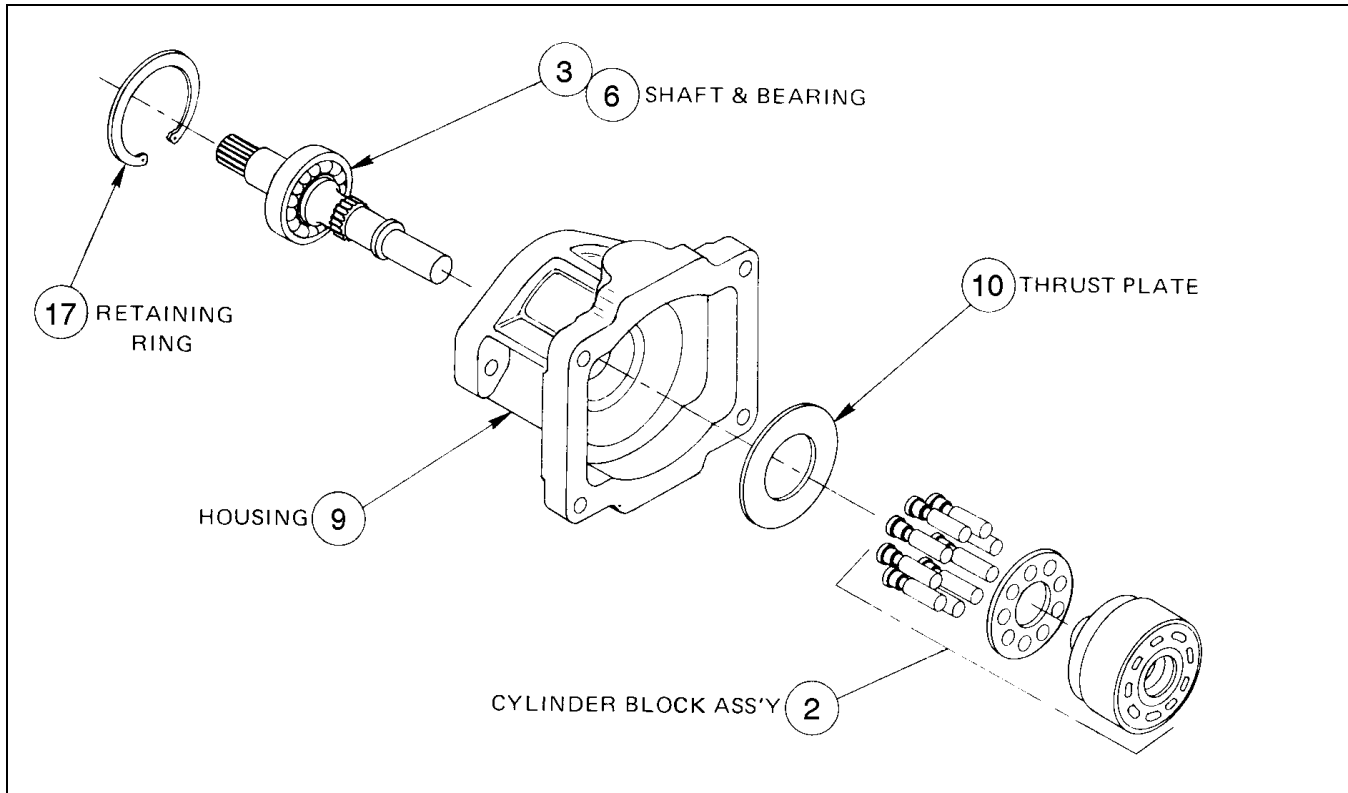


Figure 26

Lift out the cylinder block assembly (Item 2). The pistons may come out of cylinder block bores. There is no special orientation of piston to bore that needs to be maintained.

Do not attempt to disassemble the spring and other parts from the center bore of the cylinder block. The entire cylinder block assembly (Item 2) should be replaced if any of its components are damaged.

Visually inspect wear surfaces of valve plate, cylinder block and slippers for damage. Check to be sure pistons are free in bores.

Remove thrust plate (Item 10) from counter bore in motor housing (Item 9). Visually inspect both sides for damage and flatness.

The retaining ring (Item 17) must be removed prior to removal of shaft and bearing. The output shaft seal must be removed to expose the retaining ring (See Shaft Seal Replacement). The motor shaft (Item 3) and bearing (Item 8) can be pressed out of the motor housing.

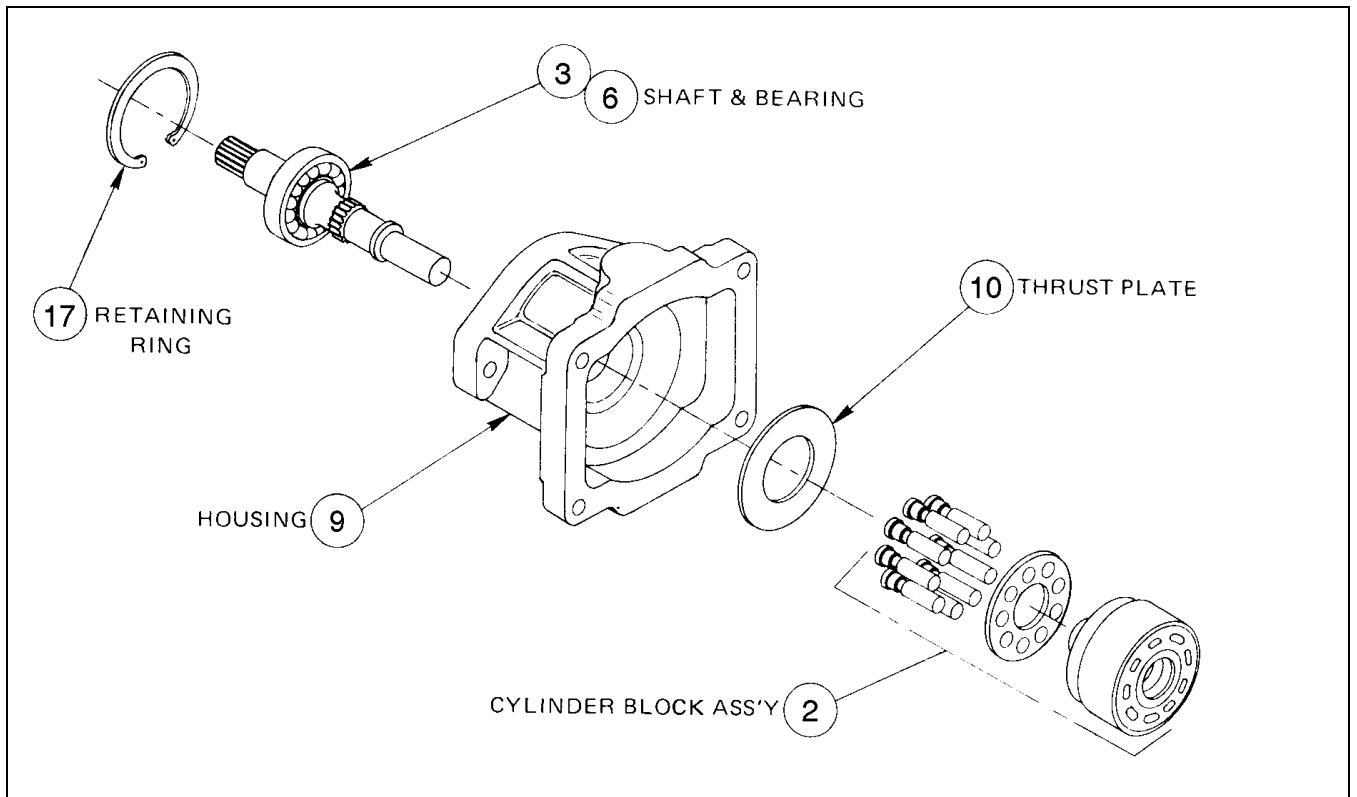


Figure 27

Press shaft (Item 3) and bearing (Item 8) together, then press into housing (Item 9). Install retaining ring (Item 17) if used.

Lubricate thrust plate (Item 10) and insert in counterbore of housing (Item 9).

Assemble cylinder block parts if necessary and lubricate with clean hydraulic oil. There is no special orientation of piston to bore that needs to be maintained.

Place the housing assembly in a horizontal position.

Slide cylinder block assembly (Item 2) over shaft and engage spline. Be certain that pistons and thrust plate remain in place. When properly installed a slight spring tension can be felt when pushing on cylinder block.

Lubricate exposed surface of cylinder block with clean hydraulic oil.

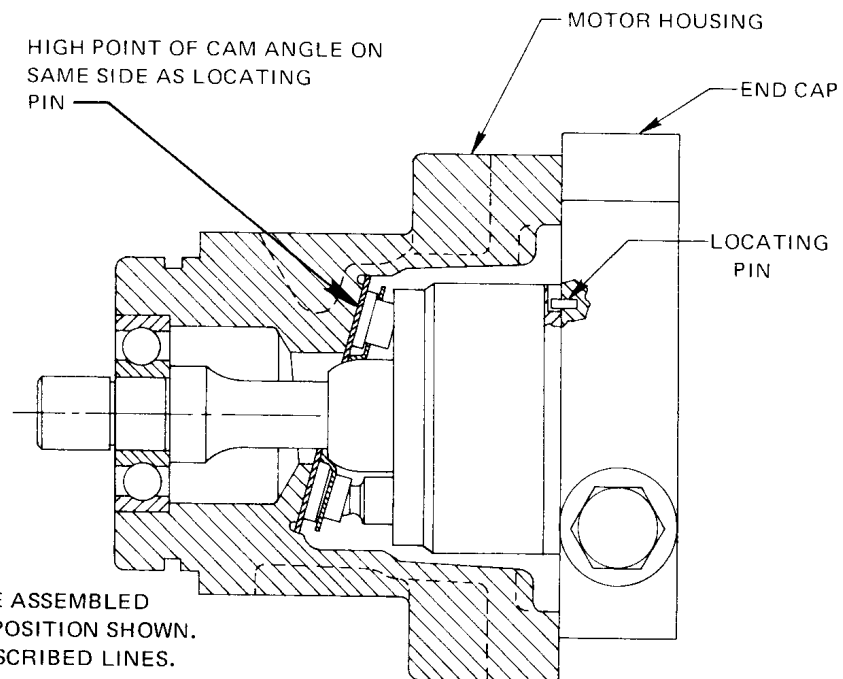


Figure 28



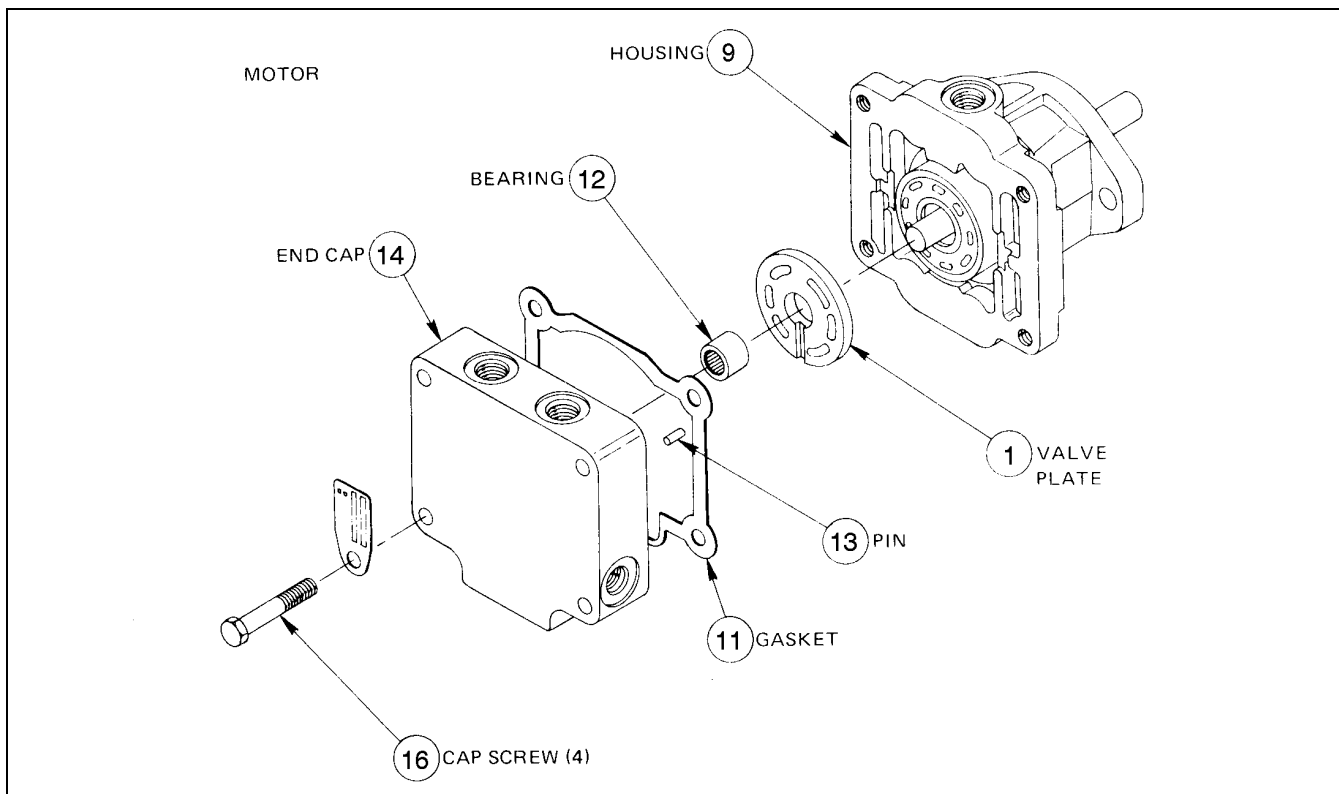


Figure 29

Properly orient the end cap (Item 14) and housing (Item 9). Refer to previously scribed lines for assembly guide.

Press the bearing (Item 11) into end cap (Item 14) leaving 3/32 to 1/8 inch of bearing protruding beyond face. The valve plate (Item 1) pilots on this bearing.

Insert locating pin (Item 13) into end cap. Lubricate the slotted side of the motor valve plate (Item 1) and slip it over the locating pin and protruding bearing.

Place gasket (Item 11) on housing (Item 9), then install end cap and valve plate. Hold the valve plate so it does not drop off during assembly.

Install four (Item 4) screws (Item 16) and tighten alternately until the end cap and housing are pulled completely together. Torque to 27-37 ft. lbs. Check for proper internal assembly by slowly rotating motors shaft while tightening these screws.

## Rear Axle 4WD Motor Repairs (Fig. 30)

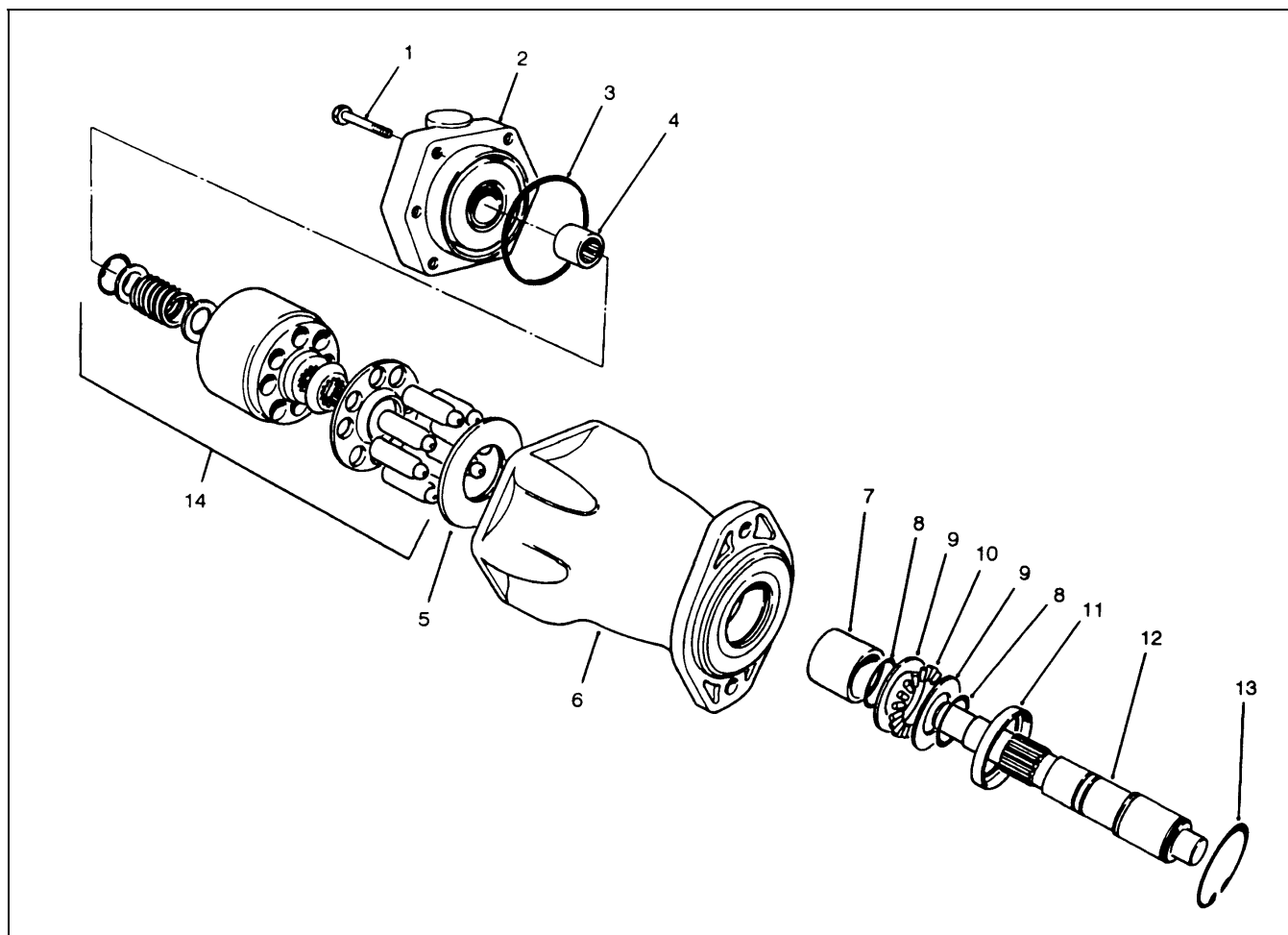


Figure 30

- 1. Capscrew
- 2. Back plate
- 3. O-ring
- 4. Bearing
- 5. Cam plate insert

- 6. Housing
- 7. Bearing
- 8. Retaining ring
- 9. Thrust race
- 10. Thrust bearing

- 11. Spacer
- 12. Drive shaft
- 13. Retaining ring
- 14. Rotating assembly

### Disassembly of Rear Axle 4WD Motor

1. Clean outside of motor thoroughly.
2. Clamp shaft in a protected jaw vise with back plate end up.
3. Remove six capscrews (Item 1) from back plate (Item 2).
4. Use a plastic mallet and tap the back plate (Item 2) to loosen it.
5. Remove o-ring (Item 3) from back plate.
6. Remove complete rotating assembly (Item 14) from housing assembly.

DO NOT attempt to disassemble the spring and other parts from the center bore of the cylinder block. The entire rotating assembly (Item 14) should be replaced if any of its components are damaged.

7. Remove camplate insert (Item 5) from housing.
8. Remove retaining ring (Item 13) from housing.
9. Remove spacer (Item 11) from housing.
10. Remove drive shaft (Item 12) with thrust bearing from housing.
11. Remove retaining rings (Item 8) from shaft and remove thrust races (Item 9) and thrust bearing (Item 10).

### Inspection of Rear Axle 4WD Motor Parts

1. Wash all parts thoroughly in a suitable solvent.
2. Examine needle bearings (Item 4) and (Item 7) in housing and back plate. Make sure they are free of excessive play and remain in the bearing cage. If needle bearings are damaged, housing (Item 6) or back plate (Item 2) should be replaced (bearings are not available separately).
3. Inspect thrust races (Item 9) and thrust bearing (Item 10). All surfaces should be free of any signs of wear or fretting.
4. Inspect spider and pivot of rotating assembly. Conical surfaces should be free of wear and score marks.
5. Inspect the pistons. The O.D. surface should be smooth and free of scoring. the shoes should be snug fit to the piston. The face of the shoes should be flat and free of scoring or flaking. DO NOT LAP SHOES on pistons.
6. Inspect piston block. The bores should be free of scoring. The surface that contacts the back plate should be smooth and free of grooves or metal buildup. DO NOT LAP PISTON BLOCK.
7. Inspect the camplate insert (Item 5). The surface should show no signs of scoring or grooves.
8. Inspect the flat surface of the back plate (Item 2). The surface should be free of excessive scoring or metal build-up. DO NOT LAP BACK PLATE.
9. Inspect the drive shaft (Item 12) for fretting in the bearing areas.

### Assembly of Rear Axle 4WD Motor Parts

1. Lubricate all moving parts with clean hydraulic oil before assembly.
2. Install one retaining ring (Item 8) in rear groove of drive shaft (Item 12). Install one thrust race (Item 9), thrust bearing (Item 10) and second thrust race (Item 9) on drive shaft. Install second retaining ring (Item 8) in front groove on drive shaft.
3. Install shaft assembly in housing (Item 6) and install spacer (Item 11).
4. Install retaining ring (Item 13).
5. Assemble rotating assembly (Item 14) by installing pivot, spider and pistons in cylinder block.
6. Lubricate camplate insert (Item 5) and install in housing.
7. Install rotating assembly (Item 14) in housing. The piston shoes must contact the camplate insert (Item 5). Make sure all parts in the proper position.
8. Install new o-ring (Item 3) on back plate (Item 2).
9. Install back plate on housing.
10. Install six (6) capscrews (Item 1) and tighten evenly to a torque of 15 - 18 ft-lb.

## Lift Valve Repairs (Fig. 31)

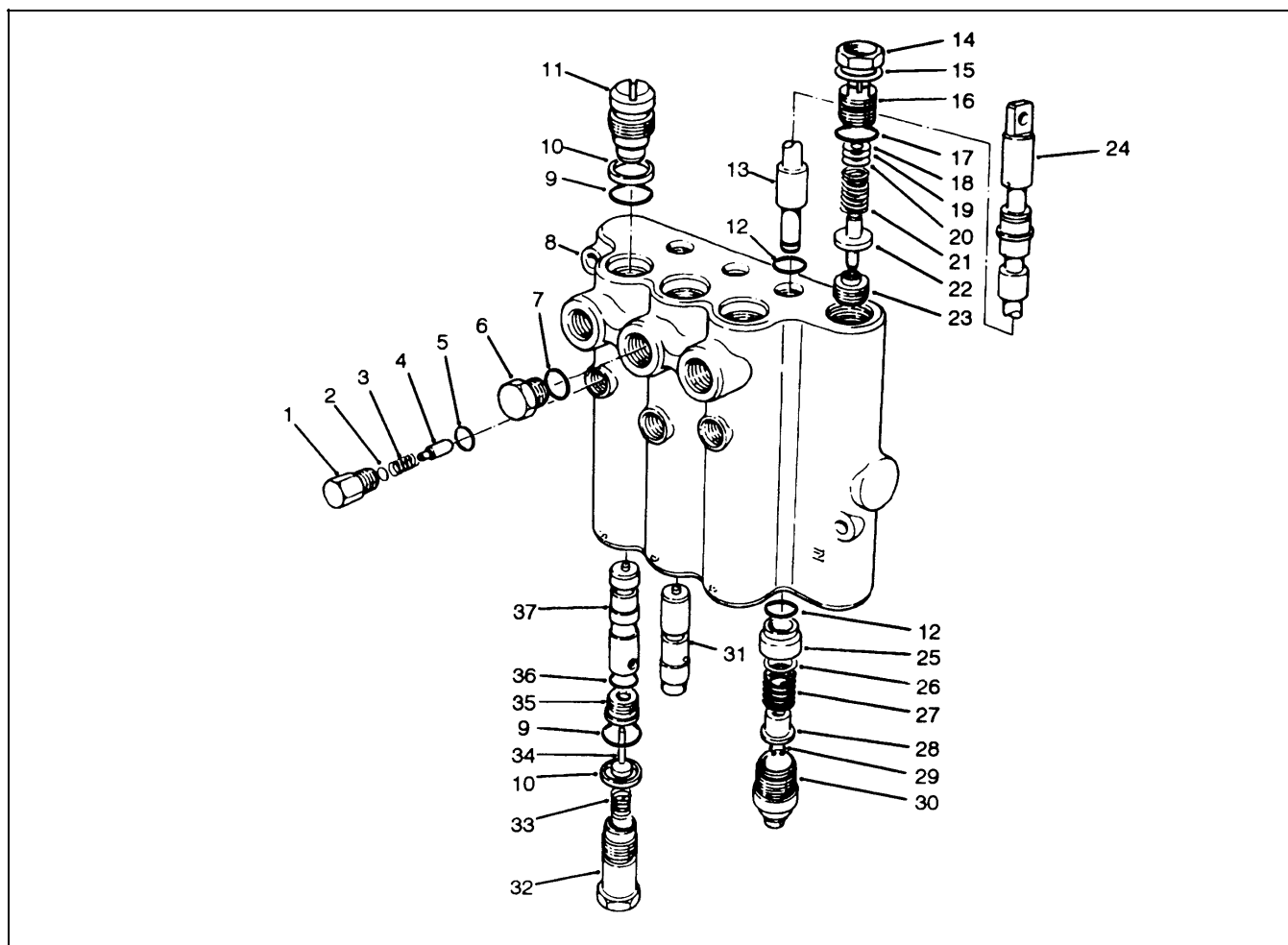


Figure 31

- |                    |                 |                    |
|--------------------|-----------------|--------------------|
| 1. Plug            | 14. Lock nut    | 27. Spring         |
| 2. Disc            | 15. Washer      | 28. Spacer         |
| 3. Spring          | 16. Plug        | 29. Retaining ring |
| 4. Detent plunger  | 17. O-ring seal | 30. Cap            |
| 5. O-ring seal     | 18. Washer      | 31. Plunger        |
| 6. Plug            | 19. Washer      | 32. Plug           |
| 7. O-ring seal     | 20. Washer      | 33. Spring         |
| 8. Body            | 21. Spring      | 34. Poppet         |
| 9. O-ring seal     | 22. Poppet      | 35. Seat           |
| 10. Back-up washer | 23. Seat        | 36. O-ring seal    |
| 11. Plug           | 24. Wiper seal  | 37. Plunger        |
| 12. O-ring Seal    | 25. Bushing     |                    |
| 13. Spool          | 26. Washer      |                    |

### Disassembly of Lift Valve

1. Plug all ports and clean outside of valve thoroughly.
2. Remove spool caps (Item 30). Do not remove retaining rings (Item 28) from spools unless spring (Item 27) is broken.
3. Remove spools (Item 13) from valve body (Item 8).  
NOTE: Spools and spool bores are matched sets. Be sure each spool is identified with the correct body spool bore.

4. Remove bushings (Item 25) and o-rings (Item 12) from spools.

5. Remove plugs (Item 11).

6. Remove plugs (Item 32), springs (Item 33), poppets (Item 34), seats (Item 35) and plungers (Item 37, 31).

**IMPORTANT: Check location and positioning of plungers when removing from body to assure proper assembly.**

7. Remove plugs (Item 6).

8. Remove plugs (Item 1), disks (Item 2), springs (Item 3) and detent plungers (Item 4).

9. Remove locknut (Item 14), washer (Item 15), plug (Item 16), washers (Item 18, 19, 20), spring (Item 21) and poppet (Item 22).

**IMPORTANT: Do not remove seat (Item 23). Seat has been set to a predetermined depth and locked in place.**

10. Remove all o-rings and back-up rings from all plugs and seats.

### Inspection of Lift Valve

1. Remove all nicks and burrs from parts and inspect for excessive wear.

2. Inspect all plungers and poppet seats for burrs or roughness.

3. Inspect spool springs (Item 27), Relief valve spring (Item 21), lockout springs (Item 33) and detent springs (Item 3) for breakage.

4. If spools have excessive wear, the valve becomes non-serviceable as the spools and spool bores are matched and damaged spools cannot be replaced.

5. Inspect relief valve poppet (Item 22) for breakage or wear.

### Assembly of Lift Valve

1. Thoroughly clean and dry all parts. Apply a light coating of clean hydraulic oil to parts prior to assembly.

NOTE: All o-rings, back-up washers, wiper seals and nylon poppets should be replaced as new items.

2. Install new o-rings (Item 12) in proper grooves in spool bores.

3. Install relief valve components (Items 22, 21, 20, 19, 18) with new o-ring (Item 17) on plug (Item 16).

4. Install plugs (Item 11) with new back-up washers (Item 10) and o-rings (Item 9).

5. Install plungers (Item 37, 31).

**IMPORTANT: Check location and positioning of plungers during installation.**

6. Install new o-rings (Item 36) on seats (Item 35). Install new back-up washers (Item 10) and o-rings (Item 9) on plugs (Item 32).

7. Install seats (Item 35), new poppets (Item 34), springs (Item 33) and plugs (Item 32).

8. Install plugs (Item 6) with new o-rings (Item 7).

9. Install detent plungers (Item 4), springs (Item 3), discs (Item 2) and plugs (Item 1) with new o-rings (Item 5).

10. If retaining ring (Item 29) has been removed to replace spool spring (Item 27), install washer (Item 26), spring (Item 27), spacer (Item 28) and secure with retaining ring (Item 29).

11. Slide bushings (Item 25) over spools. Slide new o-rings (Item 12) over spools and position next to bushings. Dip spools in clean hydraulic oil and install spool assemblies in proper location.

12. Install spool caps (Item 30) and tighten to a torque of 20 - 25 ft-lb.

13. Install new wiper seals (Item 24).

## Steering Control Unit Repair (Fig. 32)

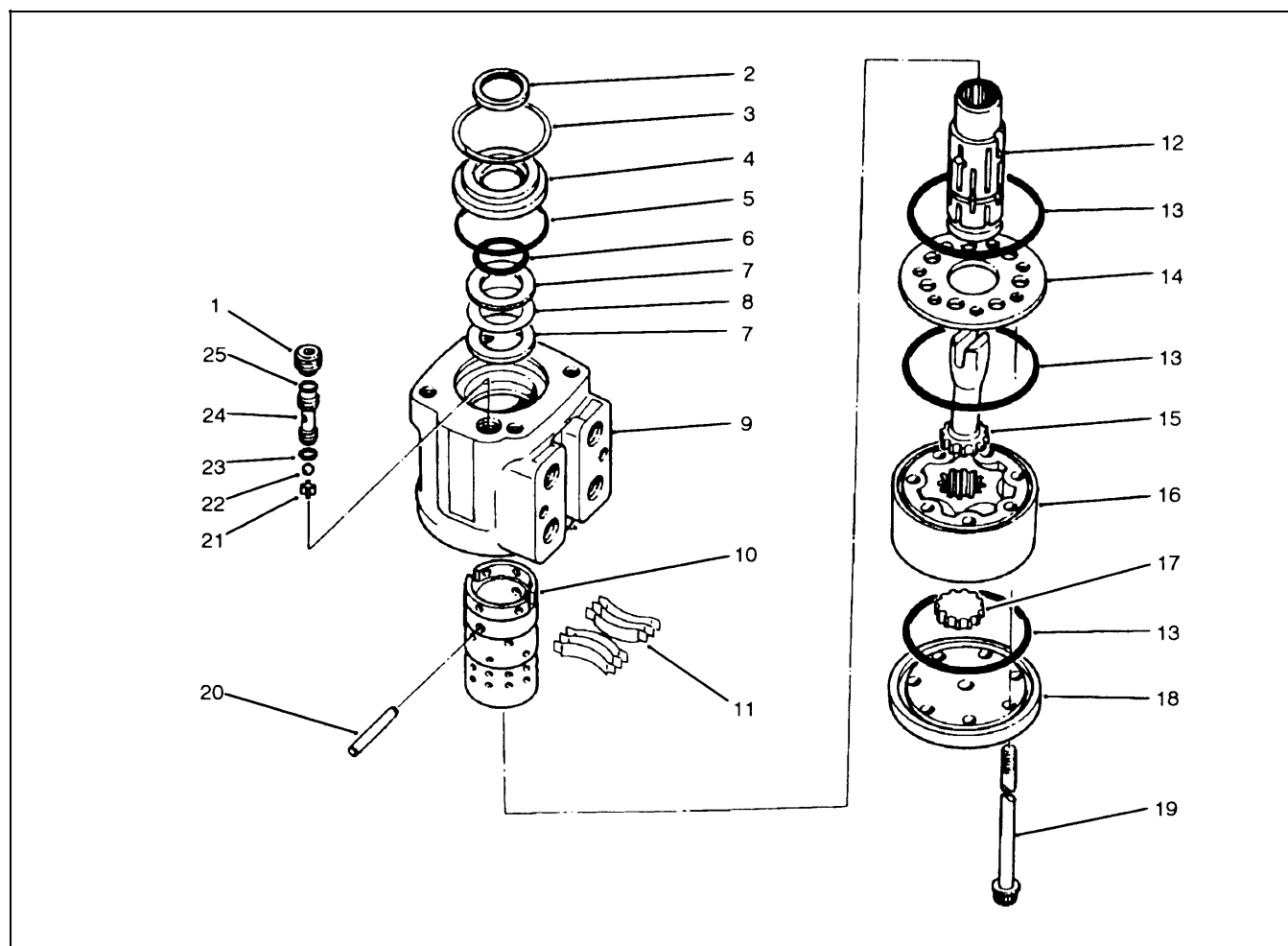


Figure 32

- |                            |                       |                         |
|----------------------------|-----------------------|-------------------------|
| 1. Set screw               | 10. Control sleeve    | 20. Centering pin       |
| 2. Dust seal               | 11. Centering springs | 21. Check ball retainer |
| 3. Retaining ring          | 12. Control spool     | 22. Check ball          |
| 4. Gland seal bushing      | 13. Seal              | 23. Seal                |
| 5. Seal                    | 14. Spacer plate      | 24. Check ball seat     |
| 6. Quad ring seal          | 15. Drive             | 25. Seal                |
| 7. Bearing race            | 16. Gerotor           |                         |
| 8. Thrust (needle) bearing | 17. Spacer            |                         |
| 9. Housing                 | 18. End cap           |                         |

### Disassembly

Cleanliness is extremely important when repairing a steering control unit. Work in a clean area. Before disconnecting lines, clean port area of unit thoroughly. Use a wire brush to remove foreign material and debris from around exterior joints of the unit.

Although not all drawings show the unit in a vise, it is recommended that you keep the unit in the vise during disassembly. Follow the clamping procedures explained in the instructions.

## Meter (Gerotor) End Disassembly

1. Clamp unit in vise, meter end up. Clamp lightly on edges of mounting area. Use protective material on vise jaws. Housing distortion could result if jaws are over-tightened.

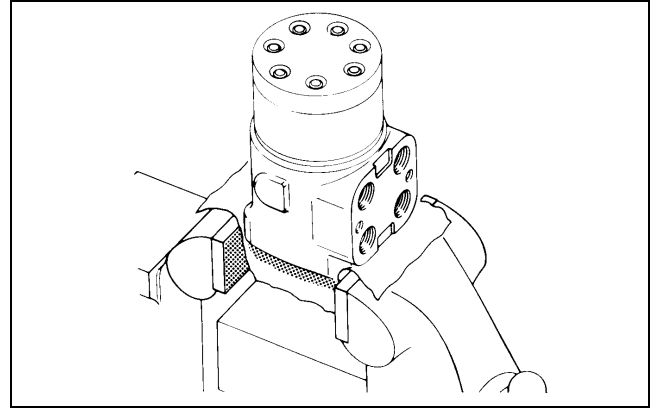


Figure 33

2. Remove 5/16" cap screws.
3. Remove end cap.
4. Remove seal from end cap.

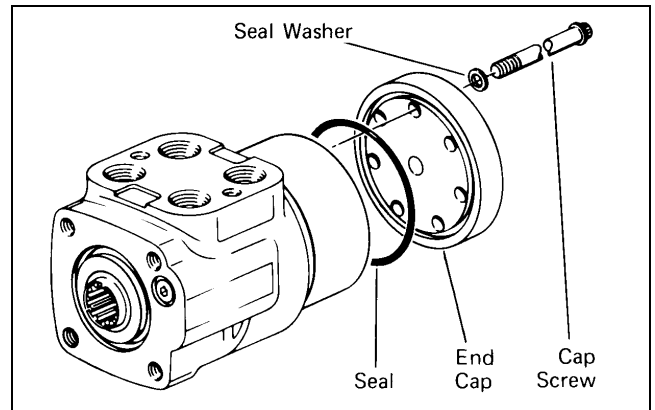


Figure 34

5. Remove meter. Be careful not to drop star.
6. Remove seal from meter.

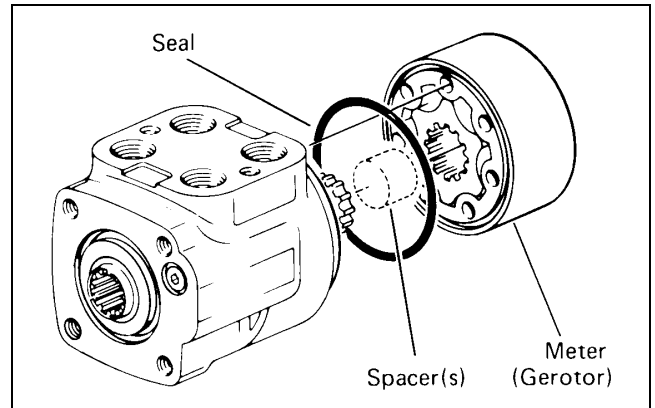


Figure 35

7. Remove drive.
8. Remove spacer plate.
9. Remove seal from housing.

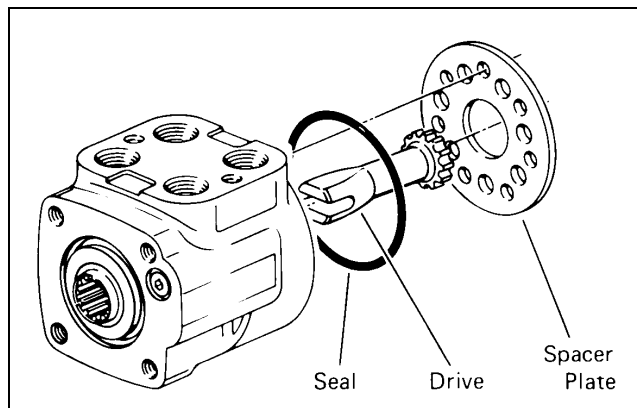


Figure 36

### Control End Disassembly

10. Remove housing from vise. Place housing on a clean soft cloth to protect surface finish. Use a thin blade screwdriver to pry retaining ring from housing.

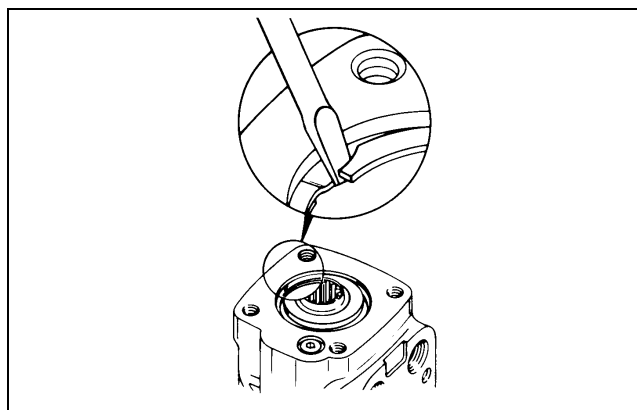


Figure 37

11. Rotate spool and sleeve until pin is horizontal. Push spool and sleeve assembly forward with your thumbs just far enough to free gland bushing from housing. Remove bushing.

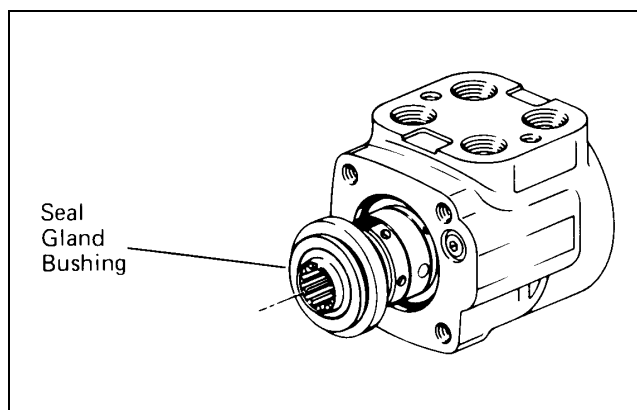


Figure 38



12. Remove quad-ring seal from seal gland bushing.

13. Use a thin blade screwdriver to pry dust seal from seal gland bushing. Do not damage bushing.

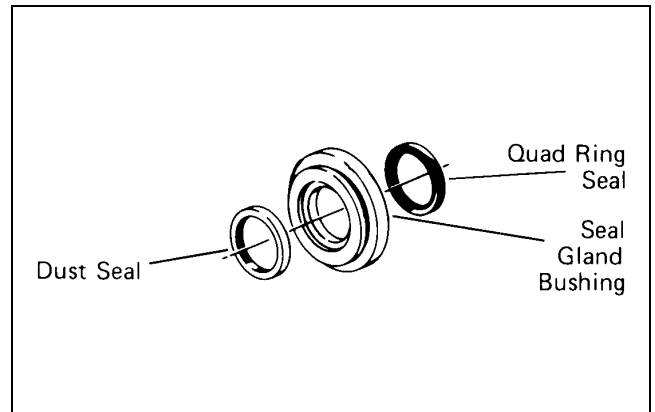


Figure 39

14. Remove 2 bearing races and the needle thrust bearing from spool and sleeve assembly.

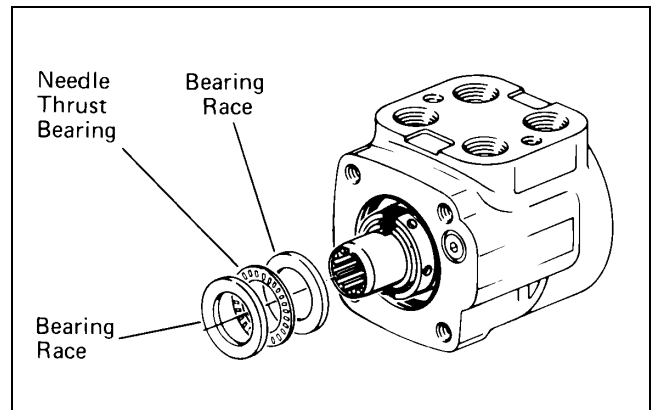


Figure 40

15. Remove spool and sleeve assembly from 14 hole end of housing.

**IMPORTANT: Do not bind spool and sleeve in housing. Rotate spool and sleeve assembly slowly when removing from housing.**

16. Push pin from spool and sleeve assembly.

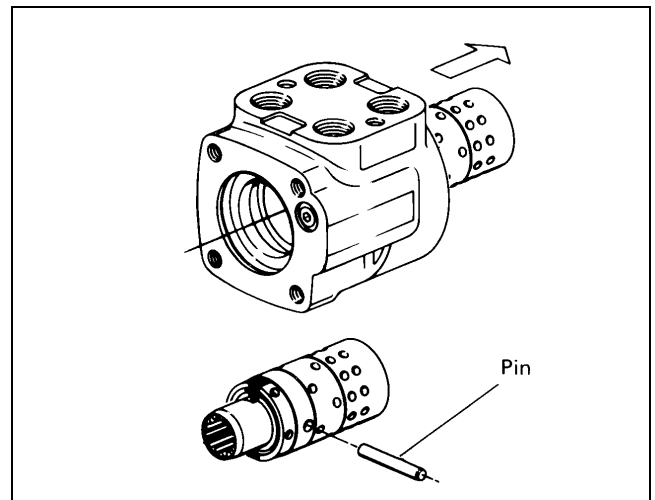


Figure 41

17. Push spool partially from control end of sleeve, then remove six (6) centering springs from spool carefully by hand

18. Push spool back through and out of sleeve. Rotate spool slowly when removing from sleeve.

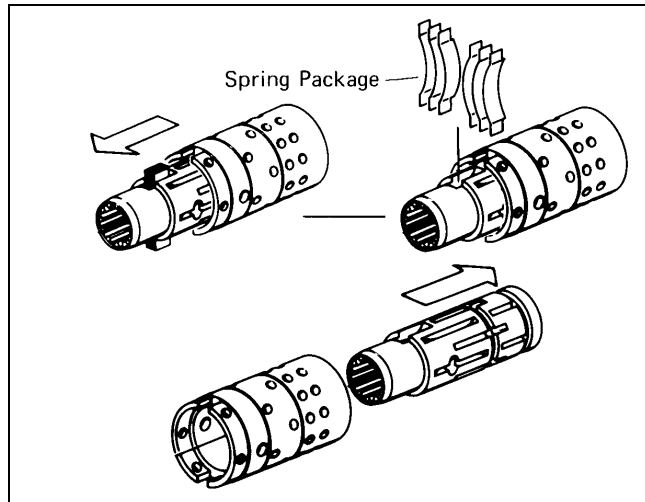


Figure 42

19. Remove seal from housing.

20. Remove set screw from housing.

21. Screw a #10-24 machine screw into end of check ball seat. Then by pulling on screw, with a pliers, lift seat out of housing.

22. Remove two (2) seals from check valve seat.

23. Tip housing to remove check ball and check ball retainer.

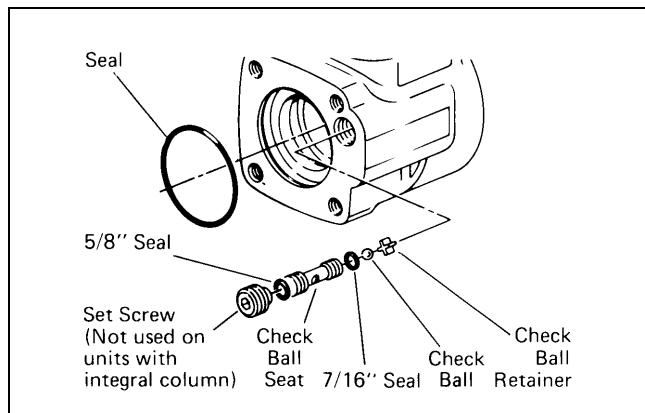


Figure 43

## Reassembly

Check all mating surfaces. Replace any parts that have scratches or burrs that could cause leakage. Clean all metal parts in clean solvent. Blow dry with air. Do not wipe dry with cloth or paper towel because lint or other matter can get into the hydraulic system and cause damage. Do not use a coarse grit or try to file or grind these parts.

NOTE: Lubricate all seals with clean petroleum jelly such as Vaseline.

Do not use excessive lubricant on seals for meter section.

Refer to parts listings covering your steering control unit when ordering replacement parts. A good service policy is to replace all old seals with new seals.

### Control End Reassembly

1. Use a needle nose pliers to lower check ball retainer into check valve hole of housing. Make sure retainer is straight (not tilted on edge) in housing.

2 Install check ball in housing.

3 Lubricate 5/8" diameter seal and 7/16" diameter seal. Install seals on check ball seat as shown

4. Lubricate check ball seat and seals thoroughly before installing seat in housing. When installing seat do not twist or damage seals. Install check ball seat in housing, insert open end of seat first. Push check ball seat to shoulder of hole.

5. Install set screw. Use a 1/4" allen wrench to torque set screw to 100 inch pounds. To prevent interference, make sure top of set screw is slightly below housing mounting surface.

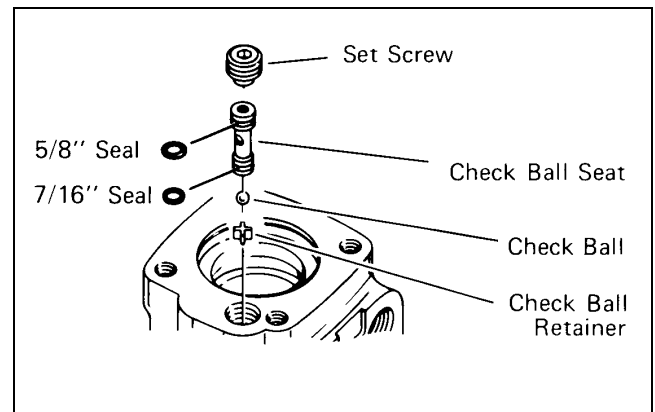


Figure 44

6. Assemble spool and sleeve carefully so that the spring slots line up at the same end. Rotate spool while sliding parts together. Some spool and sleeve sets have identification marks, align these marks as shown. Test for free rotation. Spool should rotate smoothly in sleeve with finger tip force applied at splined end.

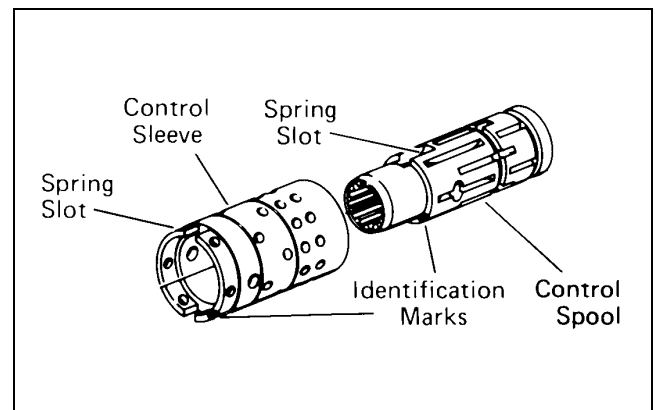


Figure 45

7. Bring spring slots of both parts in line and stand parts on end of bench. Insert spring installation tool through spring slots of both parts. Tool is available from a Eaton Hydraulics supplier as Eaton part no. 600057. Position three (3) pairs of centering springs (or 2 sets of 3 each) on bench so that extended edge is down and arched center section is together. In this position, insert one end of entire spring set into spring installation tool with spring notches facing sleeve.

8. Compress extended end of centering spring set and push into spool sleeve assembly withdrawing installation tool at the same time.

9. Center the spring set in the parts so that they push down evenly and flush with the upper surface of the spool and sleeve.

10. Install pin through spool and sleeve assembly until pin becomes flush at both sides of sleeve.

11. Position the spool and sleeve assembly so that the splined end of the spool enters the fourteen (14) hole end of housing first.

**IMPORTANT:** Be extremely careful that the parts do not tilt out of position while inserting. Push parts gently into place with slight rotating action, keep pin nearly horizontal. Bring the spool assembly entirely within the housing bore until the parts are flush at the meter end or 14 hole end of housing. Do not pull the spool assembly beyond this point to prevent the cross pin from dropping into the discharge groove of the housing. With the spool assembly in this flush position, check for free rotation within the housing by turning with light finger tip force at the splined end.

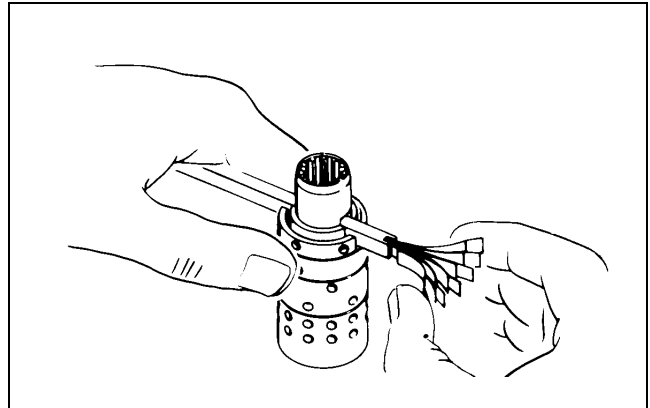


Figure 46

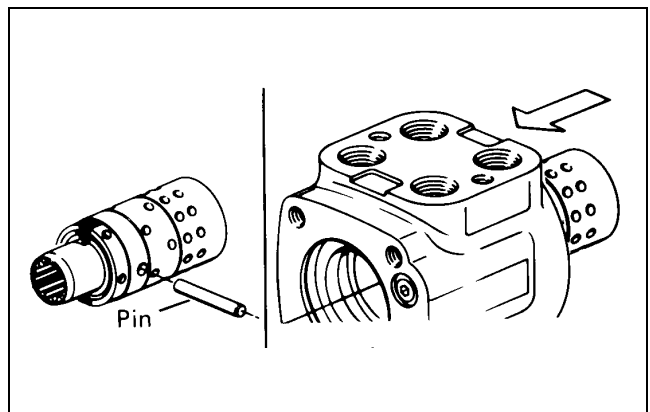


Figure 47

12. Place housing on clean, lint free cloth. Install 2-1/8" diameter seal in housing.

13. Install two (2) bearing races and the needle thrust bearing in the order shown .

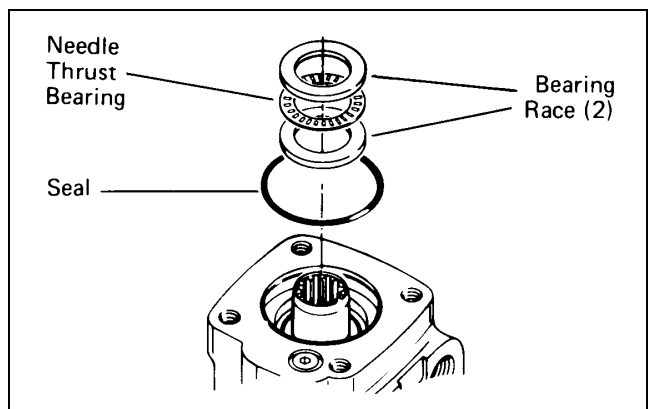


Figure 48

14. Install 1-1/4" diameter dust seal in seal gland bushing, flat or smooth side of dust seal must face down towards bushing.

15. Install the quad-ring seal in seal gland bushing. Smooth seal in place with your finger. Do not use any seal that falls freely into pocket of bushing, see Fig. 60.

16. Install seal gland bushing over the spool end with a twisting motion. Tap the bushing in place with a rubber hammer. Make sure the bushing is flush against the bearing race.

17. Install retaining ring in housing. After installing ring, tap on ring end or pry with screwdriver around entire circumference of ring to properly seat ring in groove.

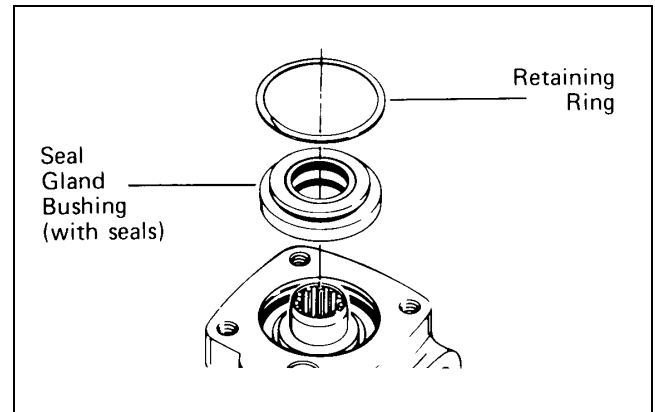


Figure 49

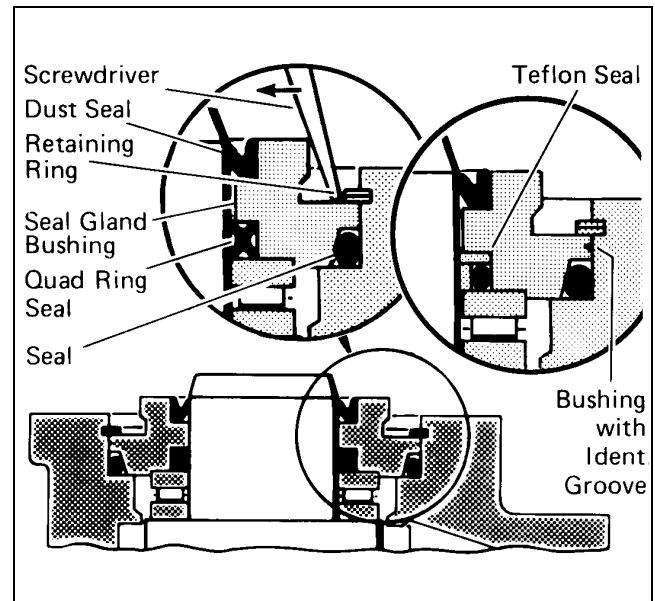


Figure 50

18. Clamp housing in vise, as shown. Clamp lightly on edges of mounting area. Do not over tighten jaws.

NOTE: Check to insure that the spool and sleeve are flush or slightly below the 14 hole surface of the housing.

**IMPORTANT:** Clean the upper surface of the housing by wiping with the palm of clean hand. Clean each of the flat surfaces of the meter section parts in a similar way when ready for reassembly. Do not use cloth or paper to clean surfaces.

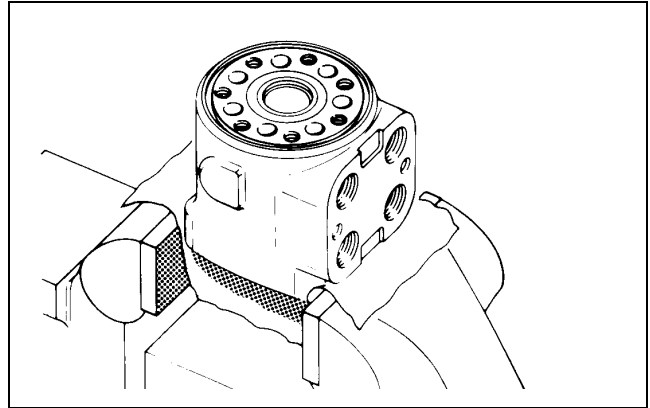


Figure 51

19. Install 3" diameter seal in housing.

20. Install spacer plate. Align bolt holes in spacer plate with tapped holes in housing.

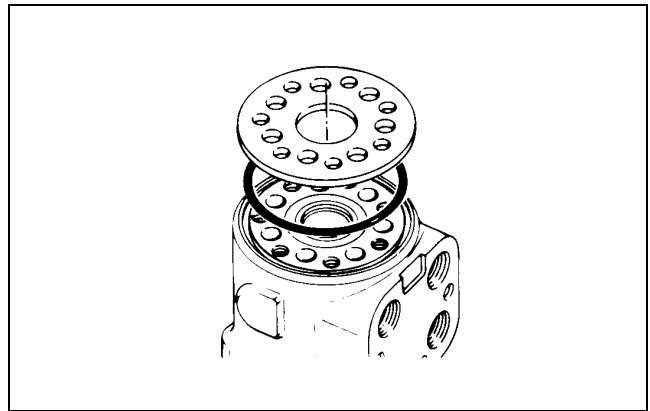


Figure 52

21. Rotate spool and sleeve assembly until pin is parallel with port face. Install drive, make sure you engage drive with pin, To assure proper alignment, mark drive as shown (ref. B). Note relationship between slotted end of drive to splined end of drive when marking.

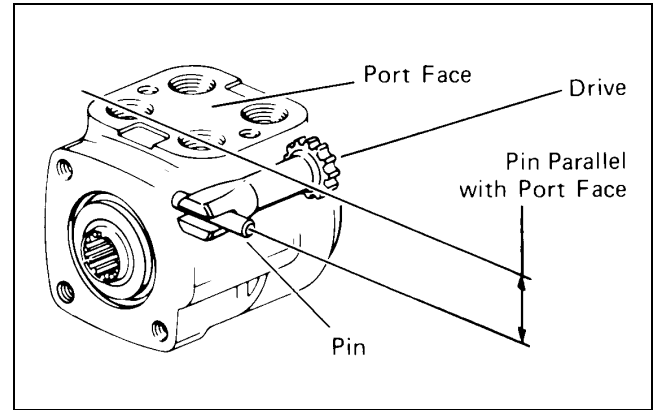


Figure 53

22. Install 3" diameter seal in meter.

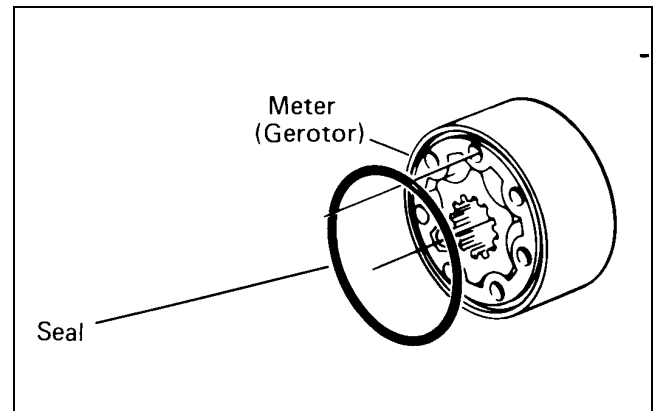


Figure 54

23. With seal side of meter toward spacer plate, align star valleys (ref. A) on drive (ref. B). Note the parallel relationship of reference lines A, B, C, and D. Align bolt holes without disengaging meter from drive.

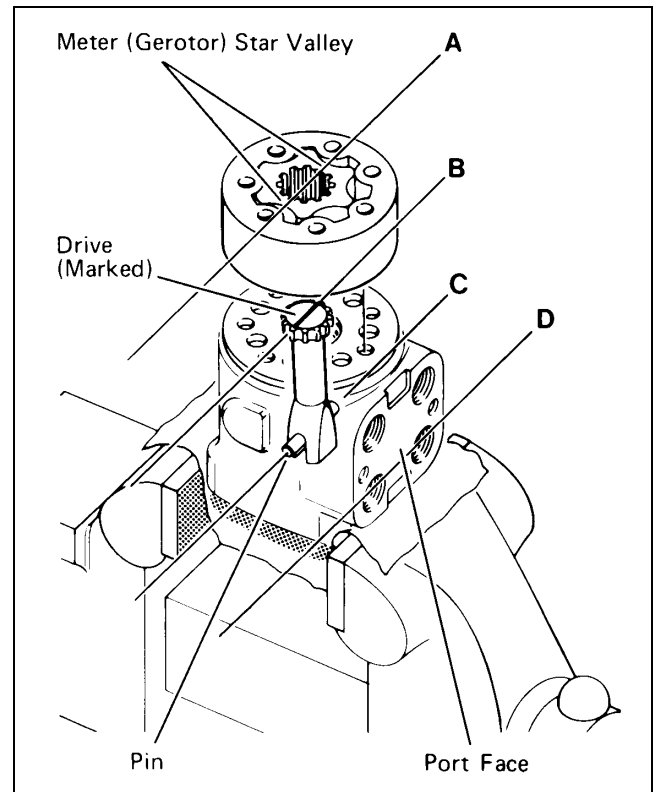


Figure 55

24. Install 3" diameter seal in end cap.
25. Install end cap on gerotor, align holes.

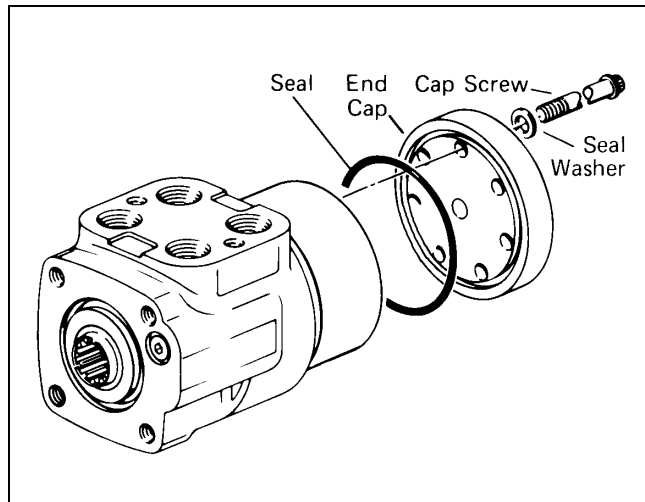


Figure 56

26. Install seven (7) DRY cap screws with new seal washers in end cap. Pre-tighten screws to 150 inch pounds, then torque screws to 275 inch pounds in sequence shown.

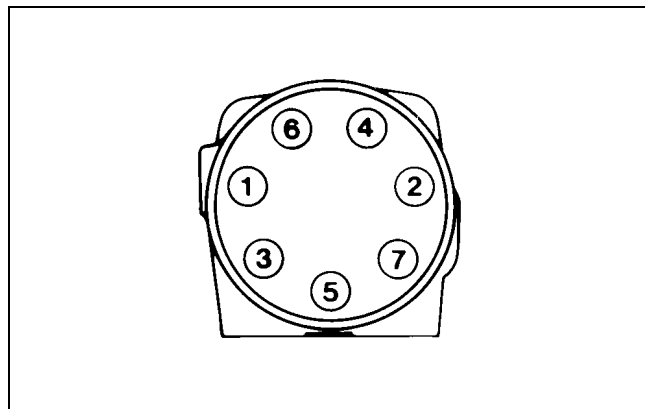


Figure 57



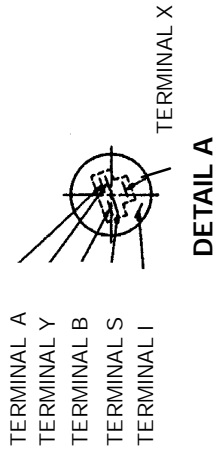
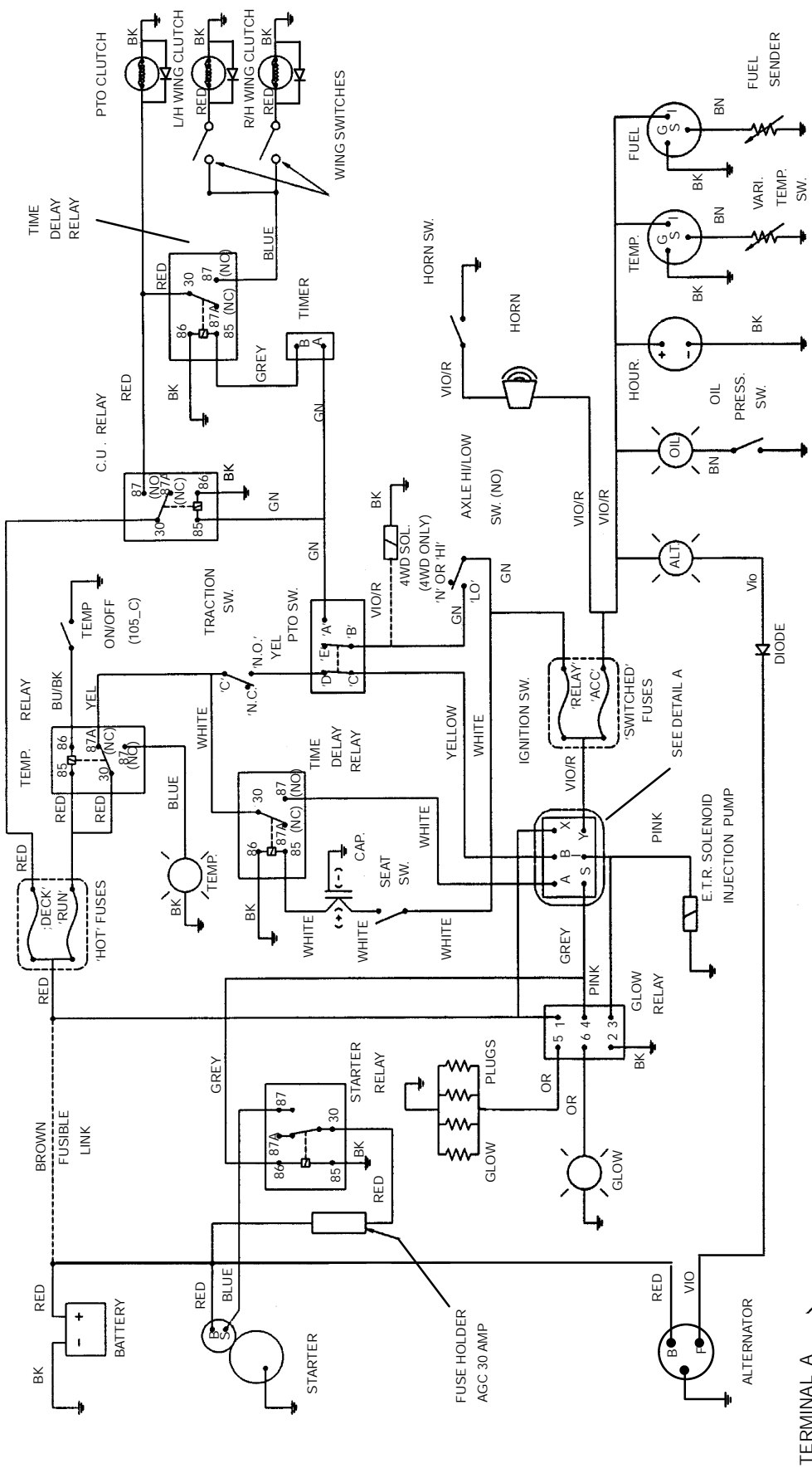


# Electrical System

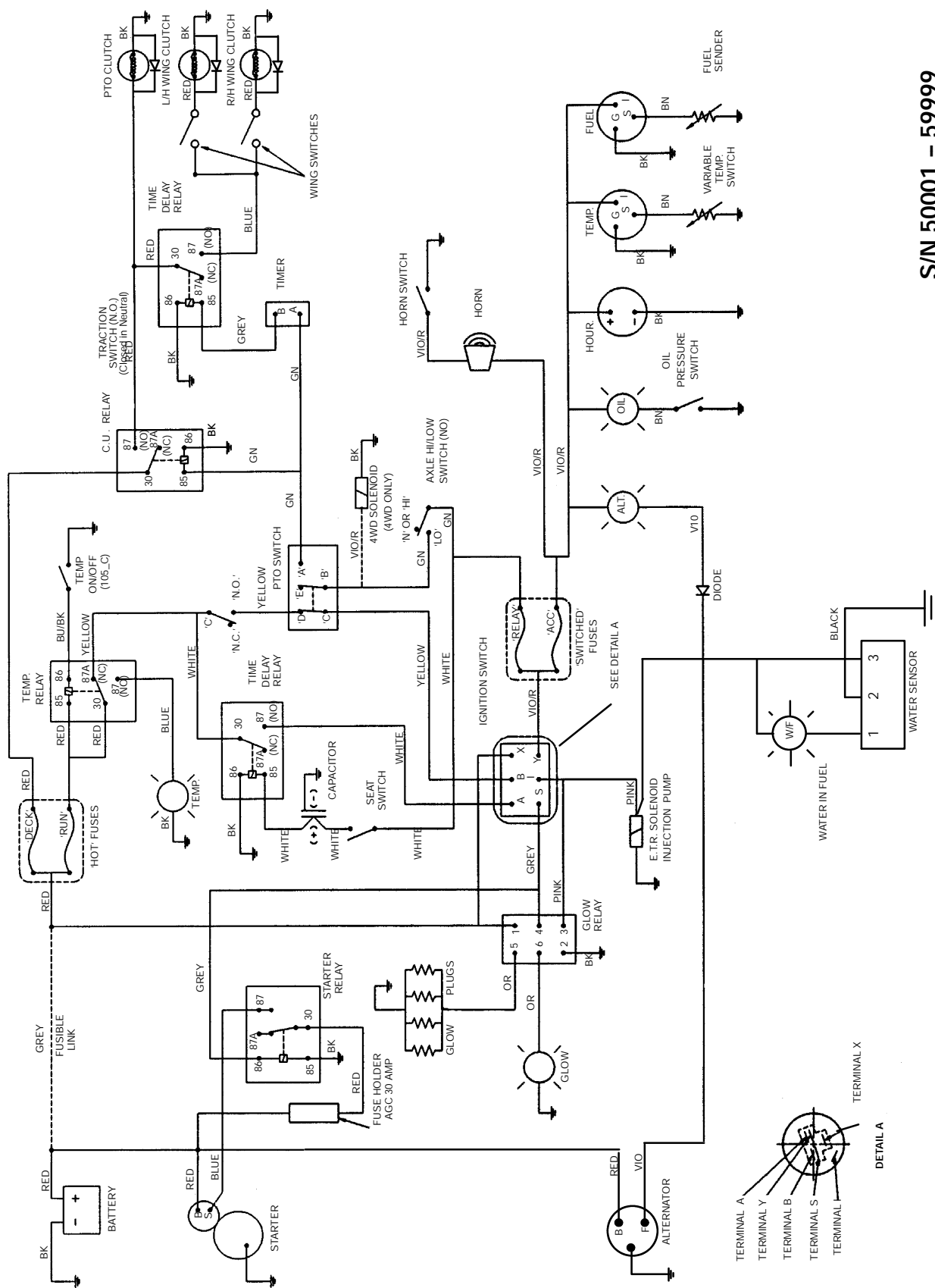
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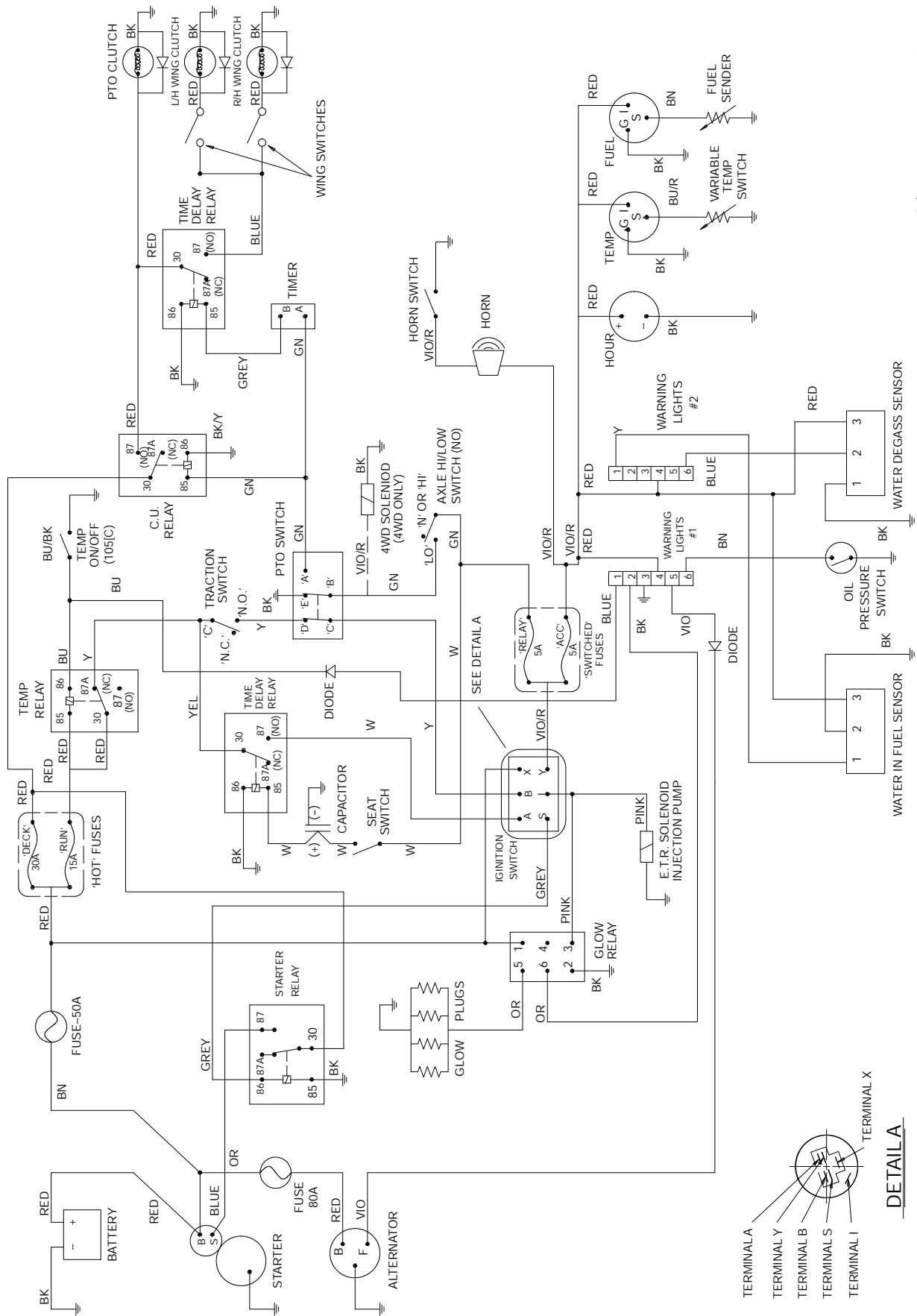
# Wiring Schematics



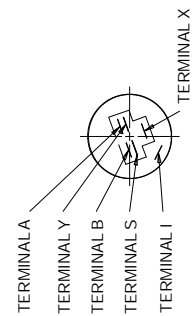
S/N 49999 & Below



S/N 50001 - 59999



S/N 60001 & UP

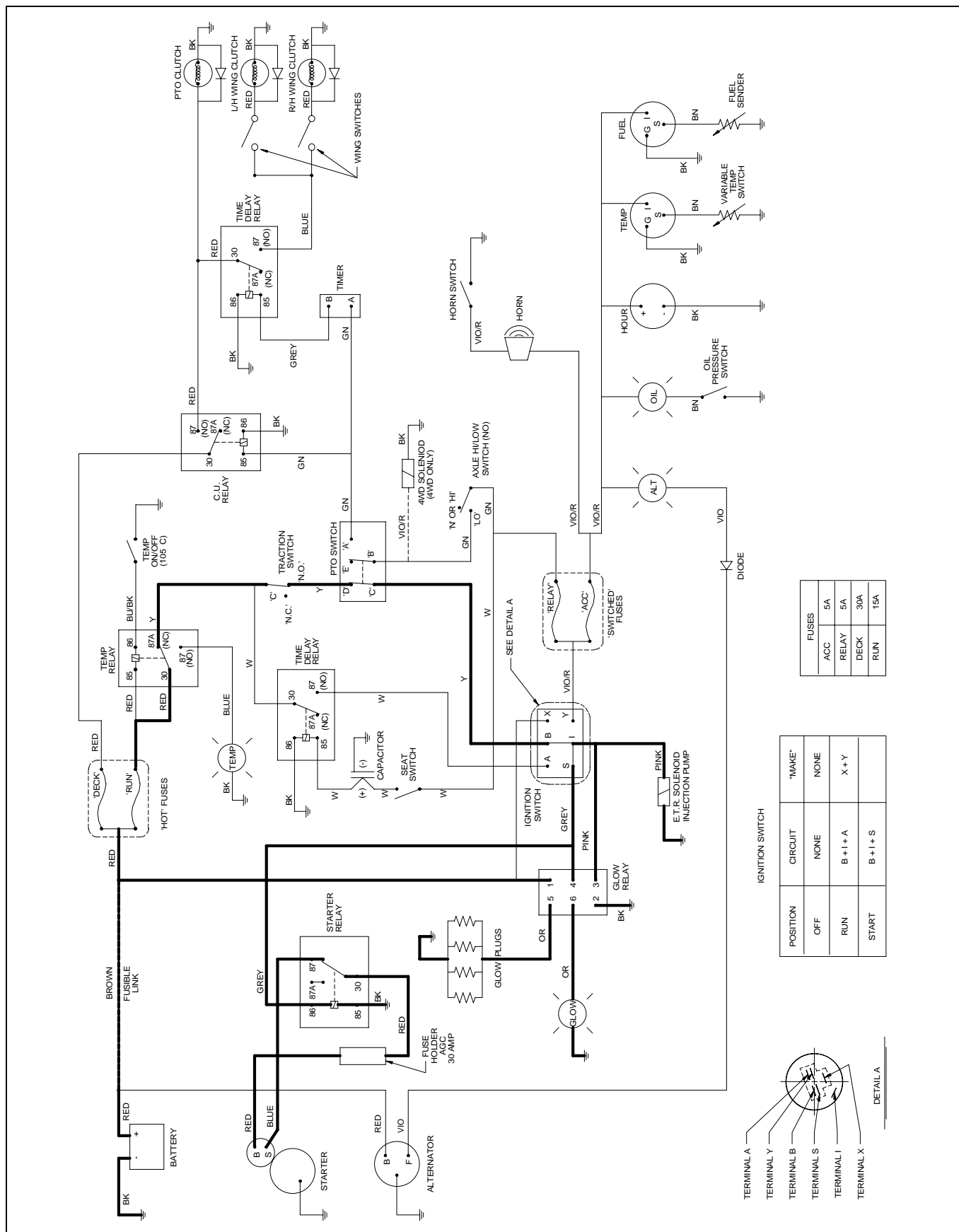


DETAIL A

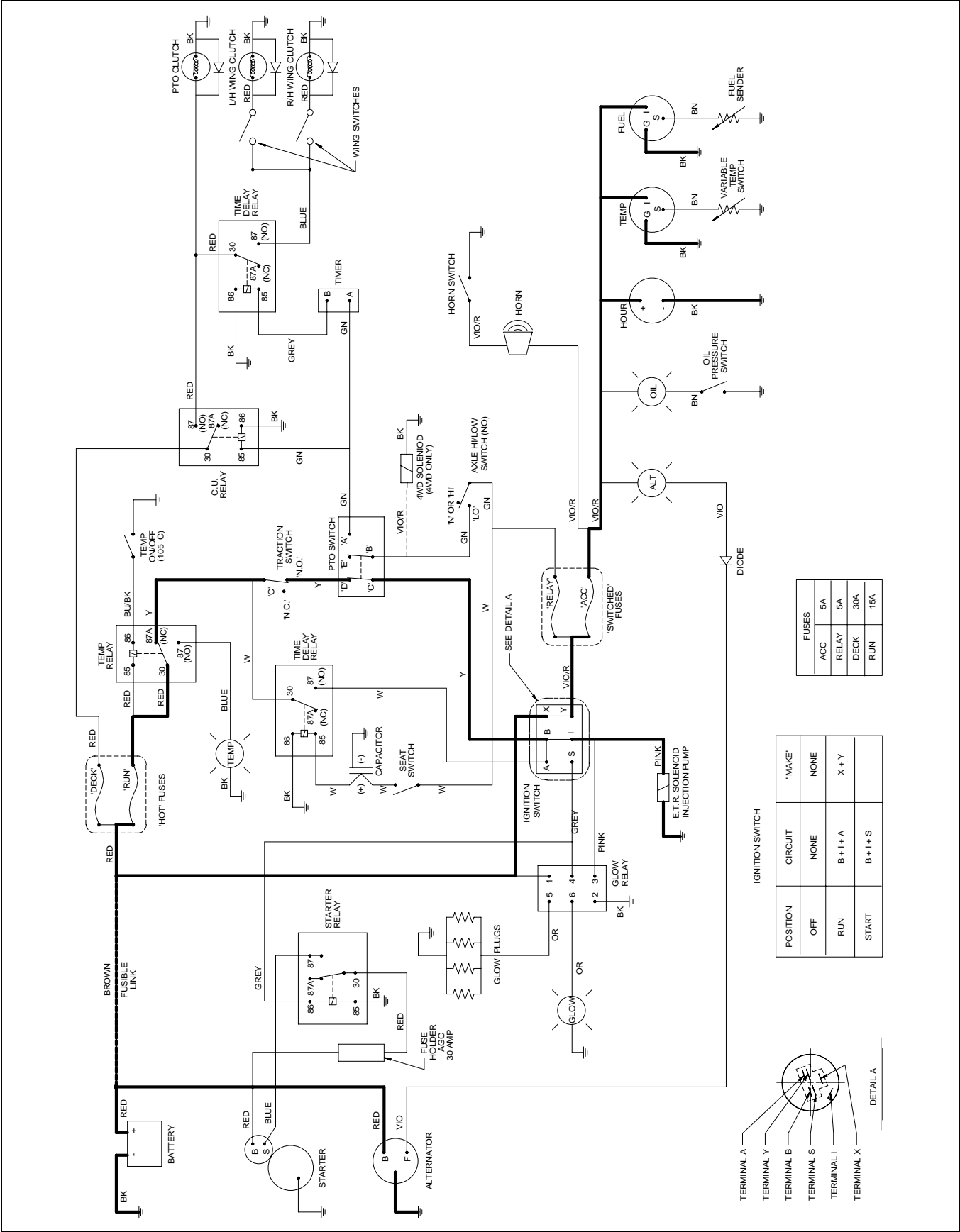


## Wiring Schematics

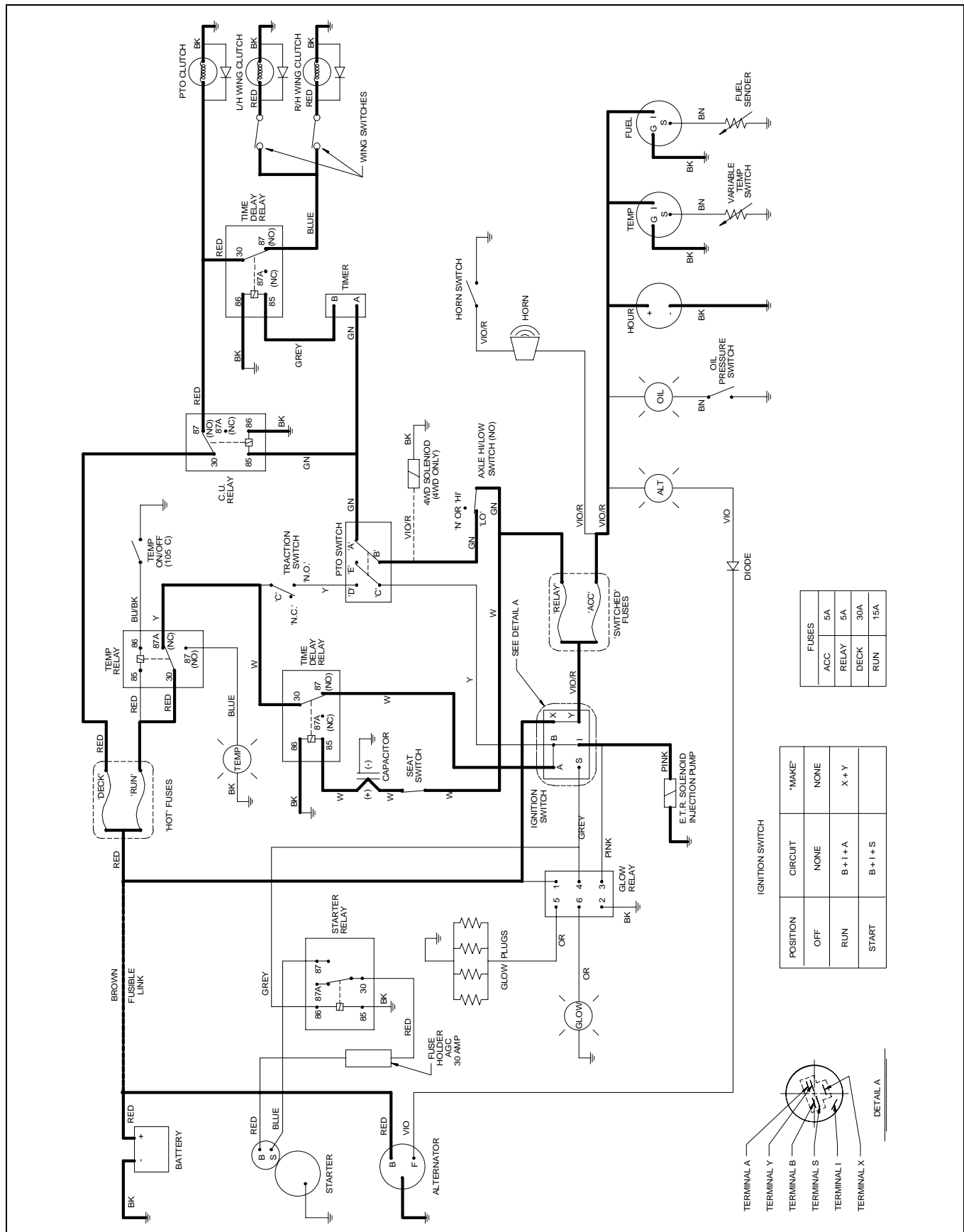
## Engine Crank and Start Circuit (S/N 49999 and Below)



Engine Run Circuit (S/N 49999 and Below)



# Engine Run and Mow Circuits (S/N 49999 and Below)





# Special Tools

NOTE: Order special tools from the *TORO SPECIAL TOOLS AND APPLICATIONS GUIDE (COMMERCIAL PRODUCTS)*. Some tools may be available from a local supplier.

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## Continuity Tester

Battery powered test lamp which is helpful in testing for continuity of circuits and electrical components when the current is off.

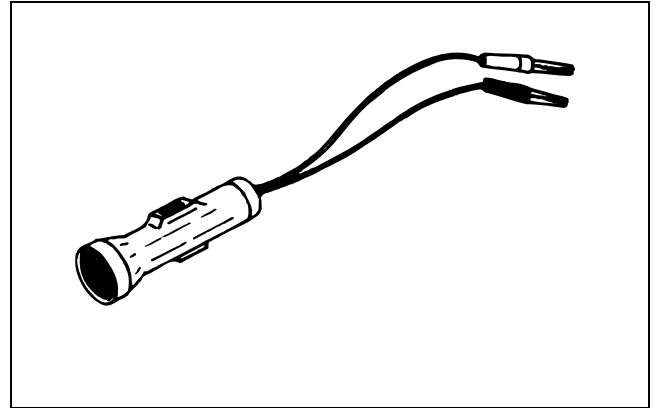


Figure 1

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## Volt - Ohm - Amp Meter

The meter can test electrical components and circuits for current, resistance, or voltage draw.

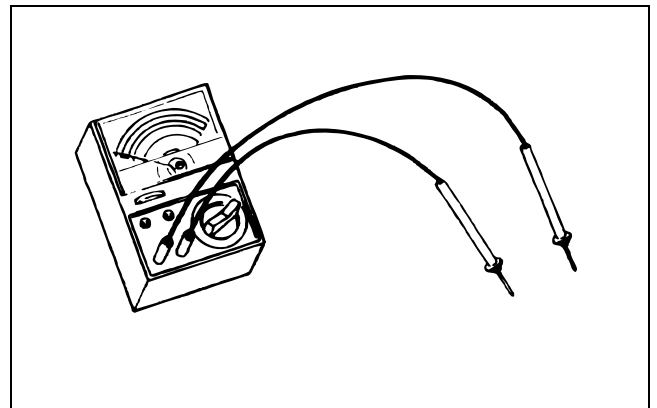


Figure 2

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## Skin-Over Grease

Special non-conductive grease which forms a light protective skin to help waterproof electrical switches and contacts.



Figure 3

# Troubleshooting



### CAUTION

Remove all jewelry, especially rings and watches, before doing any electrical troubleshooting or testing. Disconnect the battery cables unless the test requires battery voltage.

For effective troubleshooting and repairs, you MUST have a good understanding of the electrical circuits and components used on this machine. (See Electrical Schematics and Diagrams section of this chapter.)

Study the operating characteristics preceding the electrical failure to help identify the area of difficulty. Try to isolate the failure to a specific functional system; then check that area, repairing one component at a time. Attempting to repair more than one system at one time will lead to confusion.

Possible Causes and Corrections in the troubleshooting charts should be checked in the order in which they are listed.

If the machine being repaired has any interlock switches by-passed, they must be reconnected for proper troubleshooting and safety.

## Starting Problems

Condition	Possible Cause	Correction
Starter solenoid clicks, but starter will not crank. (If solenoid clicks, problem is not in interlock system.)	Low battery charge	Charge battery. Replace battery if it will not hold a charge.
	Loose or corroded battery cables.	Clean and tighten, or repair as necessary.
	Loose or corroded ground.	
	Faulty wiring at starter.	Repair wiring.
	Loose starter mounting bolts.	Clean mounting surface and tighten bolts.
	Faulty starter.	Repair or replace starter.
	Faulty starter solenoid.	Replace starter solenoid.

## Starting Problems (continued)

Condition	Possible Cause	Correction
Nothing happens when start attempt is made.	Battery is dead.	Charge battery. Replace battery if it will not hold a charge.
	Loose or corroded battery cables. Loose or corroded ground.	Clean and tighten or repair as necessary.
	"Run" fuse open.	Check fuse and replace if fuse is open. If fuse burns out often, find and correct cause.
	Fusible link open.	Replace fusible link.
	Temp. switch or relay faulty.	Test temp. switch and relay. Replace if faulty.
	Temp relay wiring loose, corroded or damaged.	Repair wiring.
	Traction switch out of adjustment or faulty.	Test traction switch. Adjust or replace traction switch if faulty.
	Traction switch wiring loose, corroded or damaged.	Repair wiring.
	PTO switch engaged or faulty.	Make sure PTO switch is OFF. Test switch and replace if faulty.
	PTO switch wiring loose, corroded or damaged.	Repair wiring.
	Ignition switch faulty.	Test ignition switch. Replace if faulty.
	Ignition switch wiring loose, corroded or damaged.	Repair wiring.
	Start relay faulty.	Test start relay. Replace if faulty.
	Start relay wires loose, corroded or damaged.	Clean and tighten or repair as necessary.
	In-line 30 amp starter solenoid fuse open.	Check fuse and replace if fuse is open. If fuse burns out often, find and correct cause.
	Starter solenoid wiring loose, corroded or damaged.	Clean and tighten or repair as necessary.
	Starter solenoid faulty.	Replace starter.

## Starting Problems (continued)

Condition	Possible Cause	Correction
Engine cranks, but does not start (if engine cranks, cause of problem is not in interlock system).	<p>Injection pump ETR solenoid wiring loose or corroded.</p> <p>Injection pump ETR solenoid faulty.</p> <p>Glow relay faulty.</p> <p>Glow relay/glow plug wiring loose, corroded or damaged.</p> <p>Glow plugs faulty.</p> <p>Engine or fuel system problem.</p>	<p>Clean and tighten or repair as necessary.</p> <p>Test solenoid. Replace if faulty.</p> <p>Test glow relay. Replace if faulty.</p> <p>Check wiring and connections. Clean, tighten or repair as necessary.</p> <p>Test glow plugs and replace if faulty.</p> <p>See Troubleshooting section of Chapter 3 - Engine.</p>
Engine cranks (but should not) with traction pedal out of neutral.	Traction switch out of adjustment or faulty.	Adjust or replace traction switch.
Engine cranks (but should not) with PTO switch ON.	PTO switch faulty.	Replace PTO switch.

## General Run and Transport Problems

Condition	Possible Cause	Correction
Engine continues to run (but should not) when traction pedal is depressed with no operator on seat.	<p>Seat switch plunger depressed with no operator on seat.</p> <p>Seat switch faulty or out of adjustment.</p> <p>Time delay relay faulty.</p>	<p>Check for seat support spring that is broken, missing or stuck in down position.</p> <p>Check for binding seat pivot hinge.</p> <p>Check for waterlogged seat.</p> <p>Test seat switch. Adjust or replace if faulty.</p> <p>Test relay. Replace if faulty.</p>
Engine kills when traction pedal is depressed or PTO switch is turned ON.	<p>Operator sitting too far forward on seat (seat switch not depressed).</p> <p>Seat hinge, support pin or spring binding, preventing seat switch from closing.</p> <p>Seat switch is faulty or out of adjustment.</p> <p>Seat switch wiring loose, corroded or damaged.</p> <p>Time delay relay faulty.</p> <p>Time delay wiring loose, corroded or damaged.</p> <p>"Relay" fuse open.</p> <p>Ignition switch faulty.</p> <p>Ignition switch or fuse wiring loose, corroded or damaged.</p>	<p>Instruct operator.</p> <p>Repair seat pivot and support.</p> <p>Test seat switch. Adjust or replace if faulty.</p> <p>Repair wiring.</p> <p>Test relay. Replace if faulty.</p> <p>Repair wiring.</p> <p>Check fuse and replace if fuse is open. If fuse burns out often, find and correct cause.</p> <p>Test ignition switch. Replace if faulty.</p> <p>Repair wiring.</p>
4WD is engaged (but should not be) with axle in "HI" range.	<p>Axle HI/LOW switch faulty.</p> <p>4WD solenoid valve faulty.</p>	<p>Test HI/LOW switch. Replace switch if faulty.</p> <p>Test 4WD solenoid valve. Replace if faulty.</p>

## General Run and Transport Problems (continued)

Condition	Possible Cause	Correction
4WD does not engage.	<p>Axle in HI range.</p> <p>Axle HI/LOW switch or plunger faulty.</p> <p>Axle HI/LOW switch wiring loose, corroded or damaged.</p> <p>4WD solenoid valve faulty.</p> <p>4WD solenoid wiring loose, corroded or damaged.</p> <p>Problem is not electrical.</p>	<p>Axle must be in Low range for 4WD to engage.</p> <p>Test HI/LOW switch. Check for proper installation and operation of plunger assembly. Replace switch or repair plunger if faulty.</p> <p>Repair wiring.</p> <p>Test 4WD solenoid valve. Replace if faulty.</p> <p>Repair wiring.</p> <p>See Troubleshooting section of Chapter 4 - Hydraulic System.</p>
Battery does not charge.	<p>Loose or broken wire(s).</p> <p>Faulty alternator.</p> <p>Dead battery.</p> <p>Alternator warning lamp is faulty or burnt out.</p> <p>Alternator warning lamp wiring loose, corroded or damaged.</p>	<p>Repair wiring.</p> <p>Check alternator belt tension. Test alternator and replace if faulty.</p> <p>Charge battery. Replace battery if it will not hold a charge.</p> <p>Replace lamp.</p> <p>Repair wiring.</p>

## Cutting Unit Operation Problems

Condition	Possible Cause	Correction
Engine continues to run (but should not) when PTO switch is ON with no operator on the seat.	<p>Seat switch plunger depressed with no operator on seat.</p> <p>Seat switch faulty or out of adjustment.</p> <p>Time delay relay faulty.</p>	<p>Check for seat support spring that is broken, missing or stuck in down position.</p> <p>Check for binding seat pivot hinge.</p> <p>Check for waterlogged seat.</p> <p>Test seat switch. Adjust or replace if faulty.</p> <p>Test relay. Replace if faulty.</p>
Wing cutting unit runs (but should not) when raised, but shuts off with PTO switch.	Wing switch faulty.	Test switch. Replace if faulty. Make sure switch is properly installed.
Wing cutting units shut off when raised, but cutting units do not shut off with PTO switch.	<p>Cutting unit relay faulty.</p> <p>PTO switch faulty.</p>	<p>Test relay. Replace if faulty.</p> <p>Test switch. Replace if faulty.</p>
Cutting units run (but should not) with axle in "HI" range.	<p>Axle HI/LOW switch or plunger faulty.</p> <p>Cutting unit relay faulty.</p>	<p>Test HI/LOW switch. Check for proper installation and operation of plunger assembly. Replace switch or repair plunger if faulty.</p> <p>Test cutting unit relay. Replace if faulty.</p>



## Cutting Unit Operation Problems (continued)

Condition	Possible Cause	Correction
No cutting units Operate.	Axle in HI range.	Axle must be in Low range for cutting units to operate.
	"Deck" fuse open.	Check fuse and replace if fuse is open. If fuse burns out often, find and correct cause.
	"Relay" fuse open.	Check fuse and replace if fuse is open. If fuse burns out often, find and correct cause.
	PTO clutch air gap out of adjustment.	Check air gap and adjust if necessary.
	PTO clutch faulty.	Test clutch. Repair or replace if faulty.
	PTO clutch wiring loose, corroded or damaged.	Repair wiring.
	Cutting unit relay faulty.	Test relay. Replace relay if faulty.
	Cutting unit relay wiring loose, corroded or damaged.	Repair wiring.
	Transaxle shift linkage out of adjustment (not closing Hi/Low switch in Low range).	Check linkage and adjust if necessary.
	Axle HI/LOW switch or plunger faulty.	Test switch. Check for proper installation and operation of plunger assembly. Replace switch or repair plunger if faulty.
	Axle HI/LOW switch wiring loose, corroded or damaged.	Repair wiring.
	PTO switch faulty.	Test switch. Replace if faulty.
	PTO switch wiring loose, corroded or damaged.	Repair wiring.
	Problem not electrical.	See Chapter 7 - PTO System.

---

## Cutting Unit Operation Problems (continued)

Condition	Possible Cause	Correction
One wing cutting unit does not operate.	Wing switch faulty.  Wing switch wiring loose, corroded or damaged.  Wing clutch air gap out of adjustment.  Wing clutch faulty.  Wing clutch wiring loose, corroded or damaged.	Test switch. Replace if faulty.  Repair wiring.  Check air gap and adjust if necessary.  Test clutch. Repair or replace if faulty.  Repair wiring.
Center cutting unit operates, but neither wing cutting unit operates.	Time delay relay faulty.  Time delay relay wiring loose corroded or damaged.  Timer faulty.  Timer wiring loose, corroded or damaged.	Test relay. Replace relay if faulty.  Repair wiring.  Test timer. Replace timer if faulty.  Repair wiring.

---

## Verify Interlock System Operation

The purpose of the interlock system is to prevent the engine from cranking or starting unless the traction pedal is in NEUTRAL and the cutting unit engagement switch is DISENGAGED. In addition, the engine will stop when the cutting unit engagement switch is engaged or traction pedal is depressed with operator off the seat.

1. In a wide open area free of debris and bystanders, lower cutting unit to the ground. Stop engine.
2. Move cutting unit engagement switch to DISENGAGED position and remove foot from traction pedal so it is fully released.
3. Rotate the ignition key to START Engine should start. If engine starts, proceed to step 4. If engine does not start, there may be a malfunction in the interlock system.
4. Raise off the seat and engage the cutting unit engagement switch while the engine is running. The engine should stop within 2 seconds. If engine stops, the switch is operating correctly – proceed to step 5. If engine does not stop, there is a malfunction in the interlock system.

5. Raise off the seat and depress the traction pedal while engine is running and the cutting unit engagement switch is DISENGAGED. The engine should stop within 2 seconds. If engine stops, the switch is operating correctly – continue operation. If engine does not stop, there is a malfunction in the interlock system.



### CAUTION

**THE INTERLOCK SWITCHES ARE FOR THE OPERATOR'S PROTECTION, SO DO NOT DISCONNECT THEM. CHECK OPERATION OF THE SWITCHES DAILY TO ASSURE INTERLOCK SYSTEM IS OPERATING. IF A SWITCH IS DEFECTIVE, REPLACE IT BEFORE OPERATING. REGARDLESS IF SWITCHES ARE OPERATING PROPERLY OR NOT, REPLACE THEM EVERY TWO YEARS TO ASSURE MAXIMUM SAFETY. DO NOT RELY ENTIRELY ON SAFETY SWITCHES - USE COMMON SENSE!**

# Testing

This section will define components, and the tests that can be performed on those components, when those parts are disconnected from the electrical system.

For accurate resistance and/or continuity checks, electrically disconnect the component being tested from the circuit (e.g. unplug the seat switch connector before doing a continuity check).

NOTE: Electrical troubleshooting of any 12 Volt power connection can also be performed through voltage drop tests without disconnection of the component.



## CAUTION

When testing electrical components for continuity with a volt-ohm meter or continuity tester, make sure that power to the circuit has been disconnected.

### Ignition Key Switch

The ignition (key) switch has three positions (OFF, RUN and START). The terminals are marked as shown.

The circuitry of the ignition switch is shown in the chart. With the use of a continuity tester, the switch functions may be tested to determine whether all circuits are being completed while the key is moved to each position.

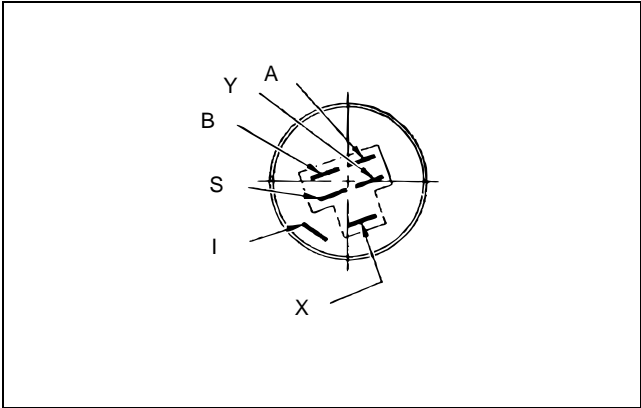


Figure 4

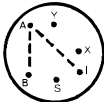
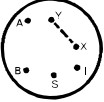
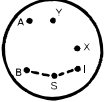
POSITION	CONTINUITY AMONG TERMINALS	OTHER CIRCUITS MADE
1. OFF	NONE	NONE
2. RUN	 B + I + A  X + Y	
3. START	 B + I + S	NONE

Figure 5

## Seat Switch, Relay and Time Delay Capacitor

The seat switch is a normally open (N.O.) switch that closes when the operator is on the seat. With no operator on the seat, there is an open circuit to the time delay capacitor and relay coil. If the PTO switch or traction switch is open and the operator raises off the seat, the engine will stop after a delay of 1 to 2 seconds.

### Seat Switch Test

1. Raise the seat to get access to the seat switch wiring connector.
2. Disconnect the seat switch wiring connector and install a continuity tester or ohm meter between the two leads of the seat switch.

3. Lower the seat. The continuity tester should show no continuity.

NOTE: Make sure the compression spring and pin holds the seat up off the seat switch when there is no operator on the seat.

4. Have the operator sit on the seat, slowly depressing the seat switch. The continuity tester should show continuity as the seat approaches the bottom of its travel.

### Relay Test

To test the relay, disconnect the relay wire connector and install a continuity tester between the relay terminals (terminals 30 and 87). The relay should make and break continuity at terminals 30 and 87 as 12 V.D.C. is connected and disconnected to terminal 85 with terminal 86 connected to ground.

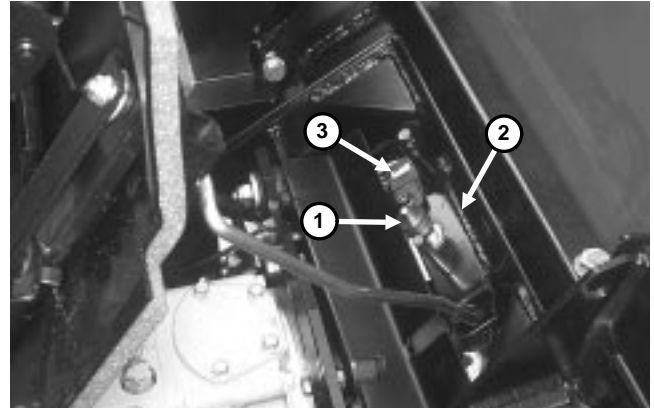


Figure 6

1. Seat switch
2. Time delay capacitor
3. Seat switch relay

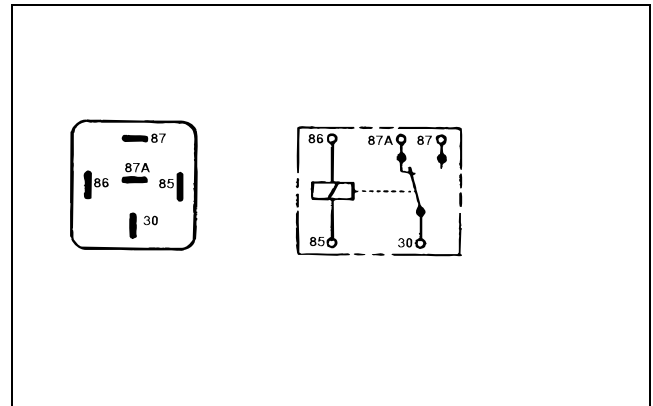


Figure 7

Relay

## Traction (Neutral) Switch

The traction switch is a normally closed and opens when traction pedal is depressed in either direction.

**IMPORTANT:** The traction switch has three (3) terminals. Make sure the wires are connected to the “COMMON” and “N.O.” terminals.

Test the switch by disconnecting the wires from the switch terminals and connecting a continuity tester across the COMMON and N.O. terminals. With the engine turned off, slowly push the traction pedal in a forward and reverse direction while watching the continuity tester. There should be indications that the traction switch is opening and closing. Allow the traction pedal to return to neutral. There should be continuity across the terminals. (See Replacing the Traction Switch in the Repairs section of this chapter for replacement and adjustment procedures.)

**NOTE:** Apply “Loctite 271” or equivalent to threads of switch screws before installing.

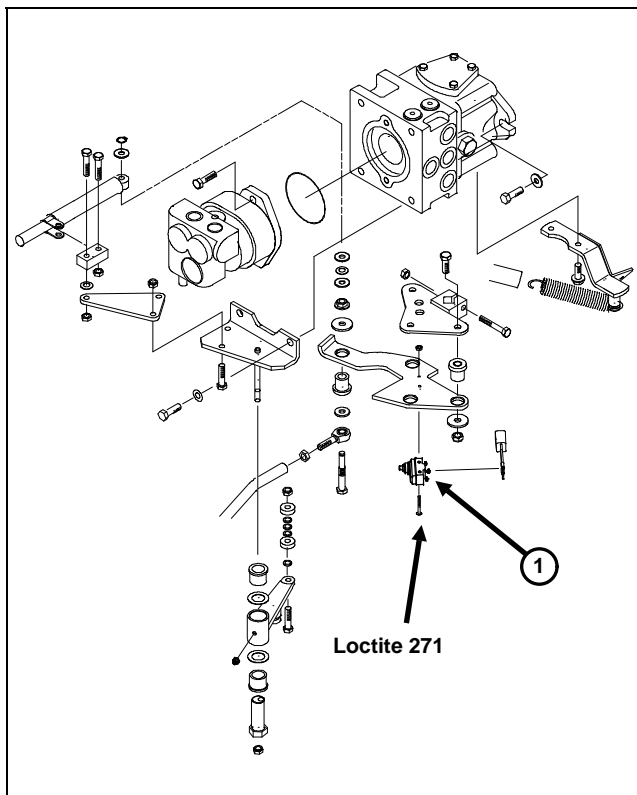


Figure 8

1. Traction (neutral) switch

## Axle Hi/Low Switch

The axle hi/low switch is normally open (N.O.) when the transaxle is in neutral or hi range. This prevents the cutting units or 4WD from engaging while the transaxle is neutral or hi range. The switch closes when the axle shift rod is moved to low range, which pushes the switch button in.

1. Disconnect the switch wire connector and install a continuity tester or ohm meter between the two leads of the switch.

2. With the axle in neutral or hi range, the switch should show no continuity. With the axle in low range the switch should show continuity.

NOTE: For proper operation, the switch must be screwed all the way in. Debris in the switch could cause the switch to not open and close properly. Shift linkage that is out of adjustment can also cause improper switch operation.

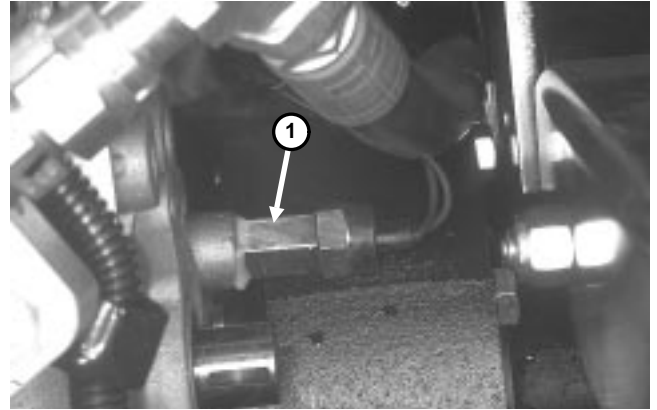


Figure 11

1. Axle Hi/Low switch

## PTO Switch

To test the PTO switch independent of wiring harness, disconnect wire connector from the switch terminals. When the switch is ON, there should be continuity between terminals A – B only. When the switch is OFF, terminals C – D and B – E should show continuity.

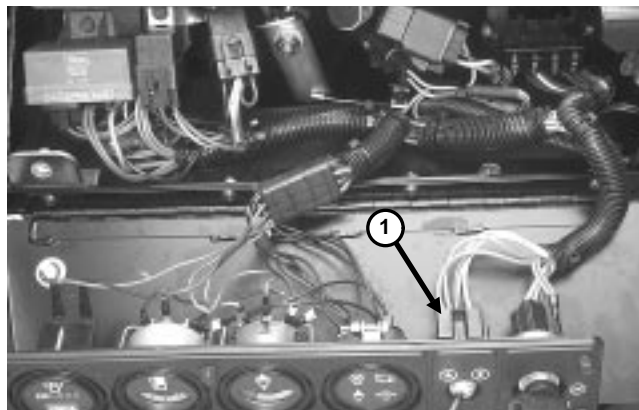


Figure 13

1. PTO switch

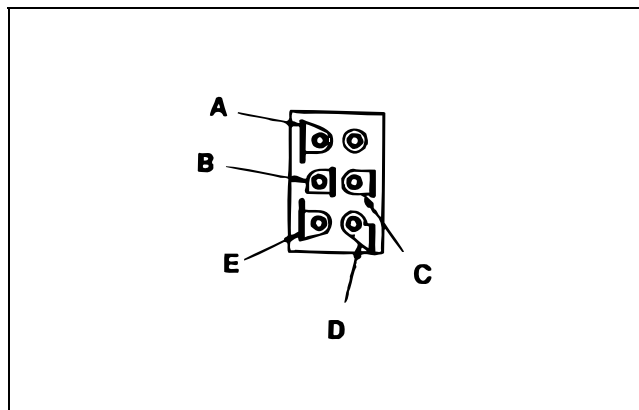


Figure 14

1. PTO switch terminals



## Start, Cutting Unit, Time Delay and High Temp. Relays

To test the relay, disconnect the relay wire connector and install a continuity tester between the relay terminals (terminals 30 and 87). The relay should make and break continuity at terminals 30 and 87 as 12 V.D.C. is connected and disconnected to terminal 85 with terminal 86 connected to ground.

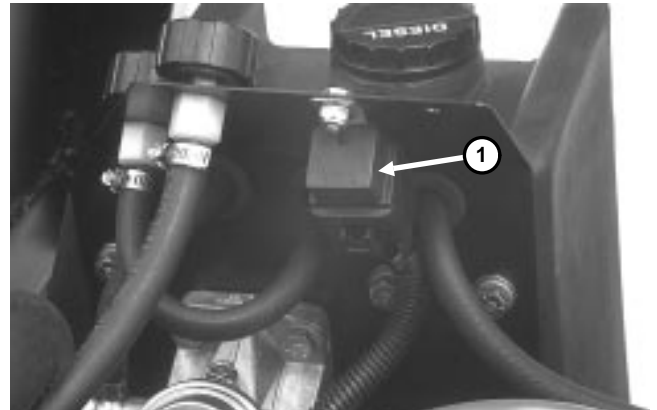


Figure 15

1. Start relay

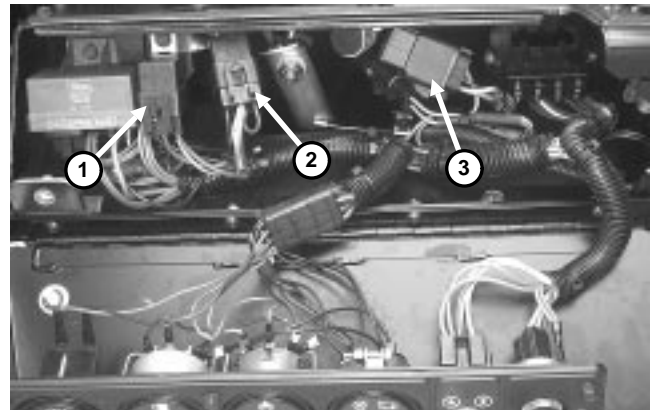


Figure 16

- 1. Cutting unit relay
- 2. High temp. relay
- 3. Wing deck time delay relay

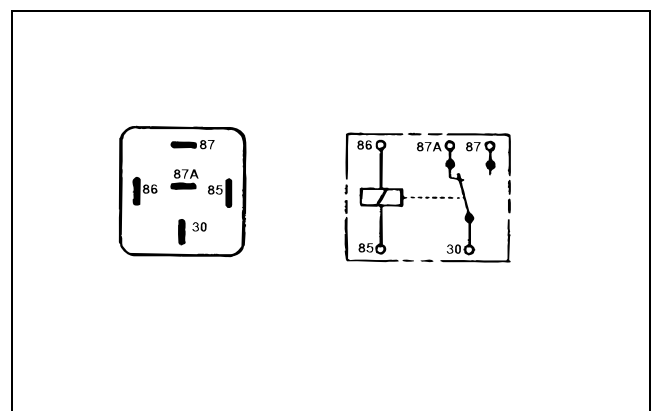


Figure 17

## Glow Relay and Glow Plugs

1. Attach an amp meter to glow plug circuit. Turn ignition switch to ON. Meter may have an initial reading as high as 100 amps.

A. If amp meter shows a reading for 5 to 12 seconds, the glow relay is operating. If there is no reading, go to step 2.

B. Turn ignition switch OFF, then ON again. A reading of 48 amps should be observed. Go to step 3.

2. To test the circuit:

A. Check with a test light at buss bar connection for glow plugs at cylinder head. Turn the ignition switch ON. If the light glows, power is being supplied from glow relay. If light does not glow check wiring or relay.

B. Check relay with a test light connected at terminal #5 on relay (glow plugs connection). Turn ignition switch ON. If the light glows, the power relay is working. If the light does not glow, check for power to relay by moving to terminal #1 (power from battery). If the light glows, check for power from ignition switch by moving to terminal #3.

4. Glow plug test:

A. Warm up the glow plugs, then check for total draw of all four (4) glow plugs:

if draw is 48 amps all four (4) are OK.

if draw is 36 amps, then one (1) is faulty.

if draw is 24 amps, then two (2) are faulty.

if draw is 12 amps, then three (3) are faulty.

if draw is 0 amps, then all are faulty.

if draw is more than 48 amps (60 to 100 amps) there is a short in one or more of the glow plugs (see Glow Plugs in Testing section of Chapter 3 - Engine).

**NOTE:** The glow relay has a built in temperature sensor and timer. Battery voltage is always available at terminal #1. When voltage is sensed at terminal 3 (ignition switch turned to ON) power is directed to terminals #5 (glow plugs) and #6 (glow indicator light). At 68°F (20°C) the glow indicator light will turn off after 5 seconds, then the glow plugs will turn off after 12 seconds. At 32°F (0°C) the glow indicator light will turn off after 10 seconds, then the glow plugs will turn off after 18 seconds.



Figure 19

1. Glow relay

---

## Battery

Use a hydrometer to test the battery. Charge the battery if necessary (see Battery Service).

### Electrolyte specific gravity

Fully charged: 1.250 - 1.280

Discharged: less than 1.240

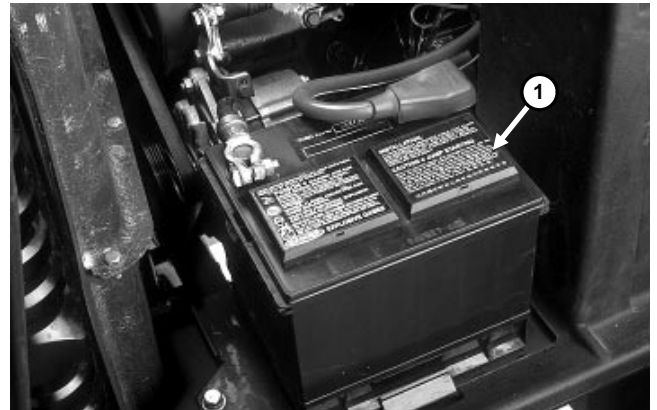


Figure 20

---

## Injection Pump (ETR) Solenoid

The Groundsmaster<sup>®</sup> 455-D has an energize-to-run (ETR) fuel stop solenoid. The solenoid will stop injector pump fuel delivery with any electrical failure in the RUN circuit.

1. Disconnect the wire from the solenoid.
2. Remove the solenoid from the injector pump.
3. Connect a 12 volt battery so that a wire from positive (+) battery terminal is connected to switch terminal. Touch a wire from the negative (-) battery terminal to solenoid body. The plunger should retract.

NOTE: You can also test operation without removing the solenoid from the injector pump. Listen for an audible “click” as the solenoid extends and retracts while doing step 3 of the above procedure. This will not show if the solenoid is fully extending and retracting.

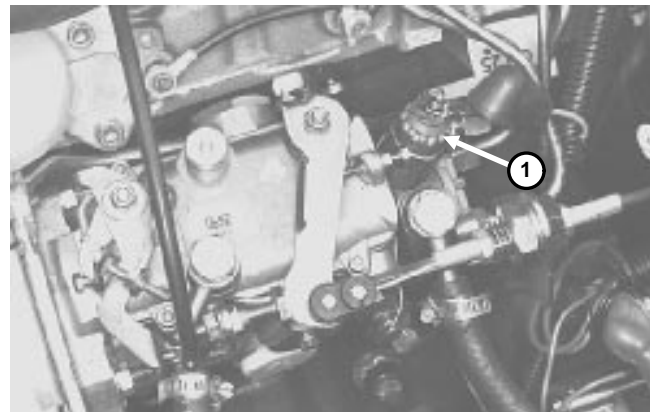


Figure 21

1. Injection pump (ETR) solenoid

---

## Gauges and Indicator Lights

### Oil Pressure Light

Oil pressure lamp should come on when the ignition key switch is in the RUN position with the engine not running or if the oil pressure switch closes during operation - oil pressure below 7 psi (0.5 kg/cm<sup>2</sup>).

Test the lamp by disconnecting the wire from oil pressure switch and grounding it against the engine. The light should come on when the wire is grounded with the ignition switch in the ON position.

### Amp Light

The amp light should come on when the ignition key switch is in the RUN position with the engine not running or if the charging circuit is not operating properly during operation.

NOTE: If amp light or amp is faulty or lamp is burnt out, the alternator will not charge properly.

Test the lamp by disconnecting the wires and applying 12 V.D.C. between the lamp wiring terminals.

### Glow Light

The glow light should come on for 5 to 12 seconds after the ignition key switch is turned ON.

Test the lamp by disconnecting the wires and applying 12 V.D.C. between the lamp wiring terminals.

### Temperature Light

The temperature light should come on only if the high temperature shut-down switch and relay has stopped the engine - coolant temperature above 221° F (105°C).

Test the lamp and relay by disconnecting the wire from high temperature shut-down switch and grounding it against the engine. The light should come on when the wire is grounded with the ignition switch in the ON position.

### Hourmeter

Test the hourmeter by connecting a 12 volt battery so the positive (+) battery terminal is connected to the positive terminal on the hourmeter. Connect the negative (-) battery terminal to the negative (-) terminal on the alternator. The hourmeter should operate as 12 V.D.C. is applied between the terminals.

### Temperature Gauge and Fuel Level Gauge

To test a gauge, use a commercial gauge tester. If a commercial gauge tester is not available, substitute a new gauge or test the sending unit.

## High Temperature Shut-Down Switch

1. Lower the coolant level in the engine and remove the high temperature shut-down switch.
2. Put the switch in a container of oil with a thermometer and heat the oil.
3. The switch is normally open (N.O.) and should close at approximately 221° F (105° C).



### CAUTION

Handle hot oil with special care to prevent personal injury or fire.

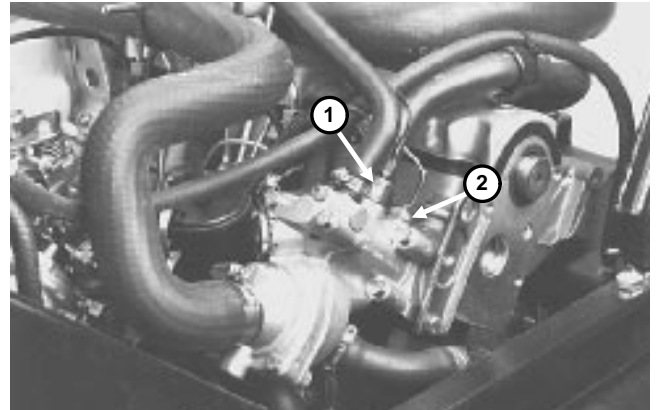


Figure 22

1. High temperature shut-down switch
2. Temperature gauge sender

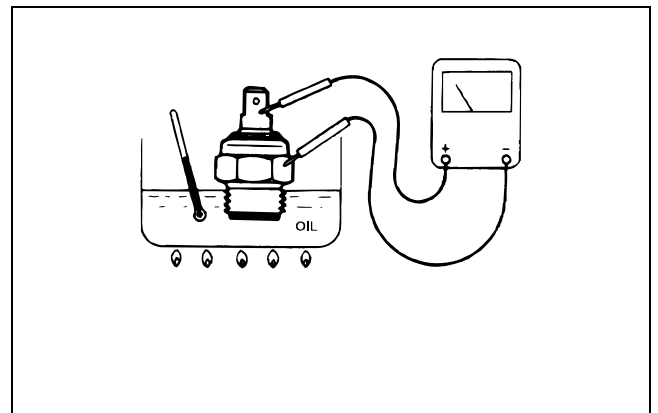


Figure 23

## Temperature Gauge Sender

1. Lower the coolant level in the engine and remove the temperature gauge sender.
2. Put the switch in a container of oil with a thermometer and heat the oil.
3. With an Ohm meter connected as shown, the following resistance readings should be indicated.

90.5 - 117.5 ohm at 160° F (70° C)  
21.3 - 26.3 ohm at 207° F (115° C)



### CAUTION

Handle hot oil with special care to prevent personal injury or fire.

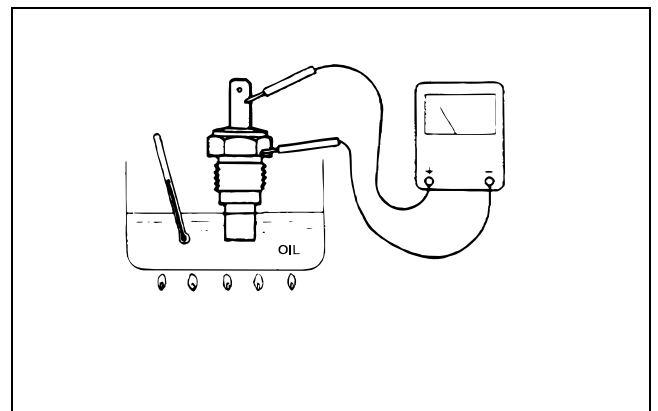


Figure 24

---

## Engine Oil Pressure Switch

The switch is normally closed (NC) and opens with pressure.

The switch opens at approximately 8 psi.

1. Turn ignition key switch ON. Oil pressure lamp should be on.

### If lamp is not on:

1. Disconnect wire from switch and touch wire to a good ground, such as the engine block.
2. If lamp comes on, replace switch.
3. If lamp does not come on check wiring between lamp and switch for continuity.

### If lamp is on with engine running:

1. Shut off engine immediately.
2. Check switch by disconnecting wire with ignition switch in ON position. Light should go out.
3. If light is still on, check for short circuit in wiring.
4. Install test gauge in engine oil pressure switch port. Start engine and check for 30 psi minimum at 1500 rpm. If engine pressure is good, replace switch. If engine pressure is low, DO NOT operate the engine.

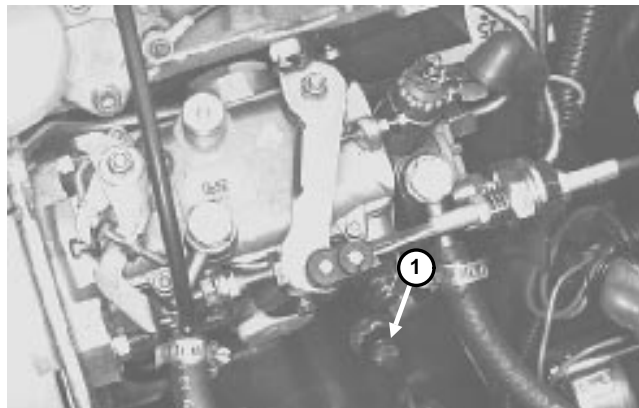


Figure 25

1. Engine oil pressure switch

---

## Fuel Gauge Sender

1. Disconnect wire and remove the fuel gauge sender from the fuel tank.
2. Install an ohm meter between the terminal and base.
3. With arm completely down (empty position), resistance should be 240 - 260 ohms.
4. With arm completely up (full position), resistance should be 29 - 34 ohms.

NOTE: Bend float arm, if necessary, to get proper gauge reading for a 1/2 full tank.



### CAUTION

**Make sure the sending unit is completely dry (no fuel on it) before testing. Perform test away from fuel tank to prevent an explosion or fire from sparks.**

---

## 4WD Solenoid

1. Disconnect the wire connector.
2. Connect a 12 volt battery so the positive (+) battery terminal is connected to colored solenoid lead. Connect the negative (-) battery terminal to black lead. The valve spool should retract completely as 12 V.D.C is applied between leads.
3. If valve spool does not operate properly check for binding or damage to valve.
4. If valve moves smoothly, but does not engage when 12 V.D.C is applied to solenoid leads, replace solenoid coil.
5. If valve still does not operate after replacing solenoid coil, replace the valve.

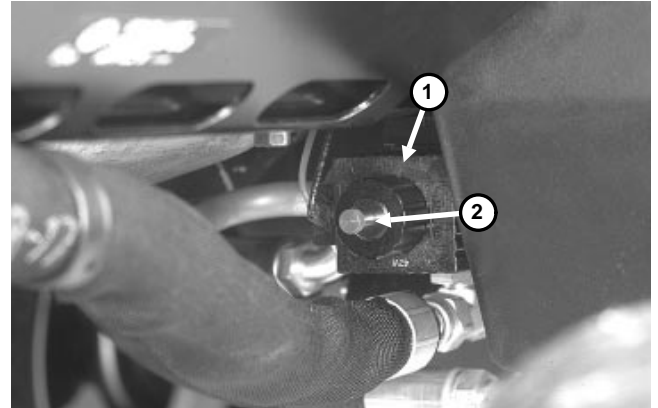


Figure 28

- 1. 4WD solenoid
- 2. Indicator

---

## Wing Switch

The wing switch is closed with the wing cutting unit lowered and open when wing cutting unit is raised.

**IMPORTANT: The wing switches have three (3) terminals. Make sure the wires are connected to the “COMMON” and “N.O.” terminals.**

Test the switch by disconnecting the wiring connector for the switch and connecting a continuity tester across the terminals. With the engine running and the P.T.O. DISENGAGED (OFF), raise and lower the affected wing cutting unit while watching the continuity tester. With the wing raised, there should be no continuity. When the wing is lowered there should be continuity.

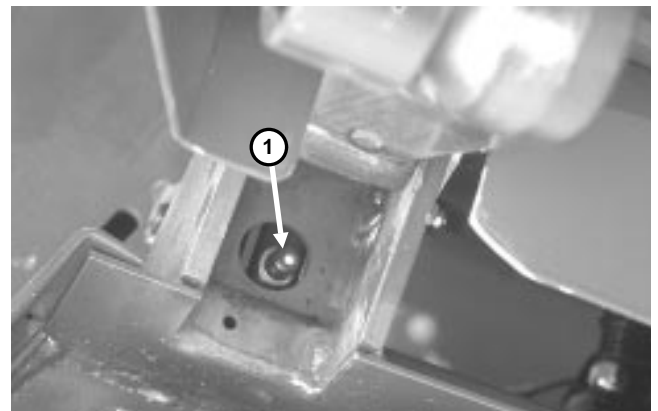


Figure 29

- 1. Wing switch  
(Shown from below wing with wing in raised position)

## P.T.O. Clutch and Wing Clutch

1. Park machine on a level surface, engage parking brake, lower the cutting units and turn engine OFF.
2. Disconnect electrical connector from affected clutch.

### Continuity Test

Connect a continuity tester or ohmmeter to the two (2) terminals of the electrical connector on the clutch. If continuity is not present, replace the clutch or electro-magnet part of the clutch (see Chapter 7 - P.T.O System or Chapter 8 - Cutting Unit).

### Operation Check

Connect a 12 volt battery to the terminals of the electrical connector on the clutch. The clutch should engage when voltage is applied to the terminals.

NOTE: Make sure clutch air gap is adjusted to 0.011 - 0.021 inches (see Chapter 7 - P.T.O. System or Chapter 8 - Cutting Unit).

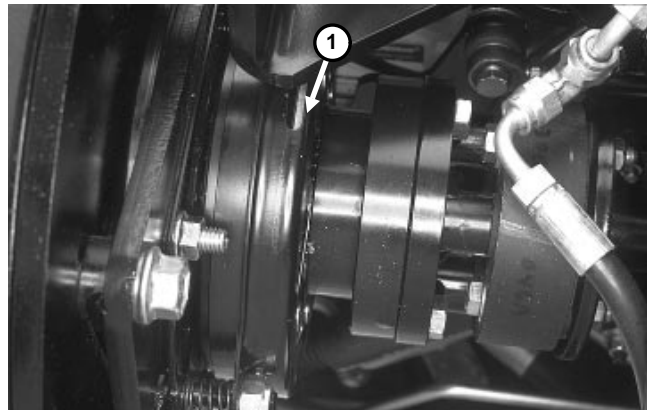


Figure 30

1. P.T.O. clutch

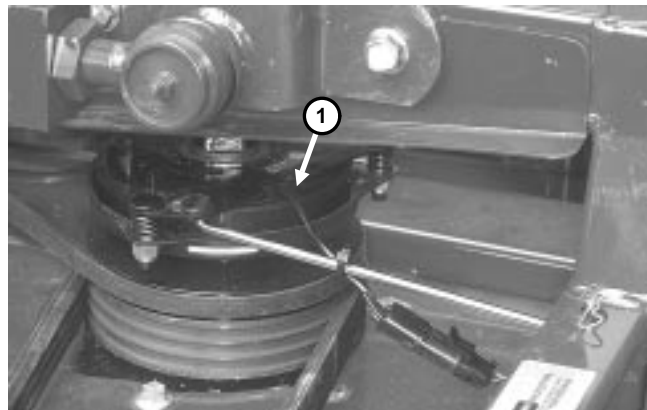


Figure 31

1. Wing clutch



# Repairs

**IMPORTANT:** Before welding on the machine, disconnect both battery cables from the battery and disconnect the terminal connector from the alternator to prevent damage to the electrical system.

## Battery Service

**IMPORTANT:** To prevent damage to electrical components, do not operate the engine with the battery cables disconnected.

Keep the terminals and entire battery case clean. To clean the battery, wash the entire case with a solution of baking soda and water. Rinse with clear water. Do not get the soda solution into the battery because damage to the battery will result. Coat the battery posts and cable connectors with skin-over grease, or petroleum jelly to prevent corrosion.

Check for loose battery hold-downs. A loose battery may crack or cause the container to wear and leak acid.

Check the electrolyte solution to make sure the level is above the plates. If the level is low (but above the plates inside the battery), add water so the level is to the bottom of the cap tubes. If the level is below the plates, add water only until the plates are covered and then charge the battery. After charging, fill the battery to the proper level.



### CAUTION

Do not charge a frozen battery because it can explode and cause injury. Let the battery warm to 60° F (16° C) before connecting to a charger.

Charge the battery in a well-ventilated place so that gases produced while charging can dissipate. Since the gases are explosive, keep open flame and electrical spark away from the battery; do not smoke. Nausea may result if the gases are inhaled. Unplug the charger from the electrical outlet before connecting or disconnecting the charger leads from the battery posts.

### Electrolyte Specific Gravity

Fully charged: 1.250 - 1.280  
Discharged: less than 1.240

### Battery Specifications

BCI Group 26 SMF-5 Battery:  
530 Amp Cranking Performance at 0° F (-17° C)  
85 min. Reserve Capacity at 80° F (27° C)

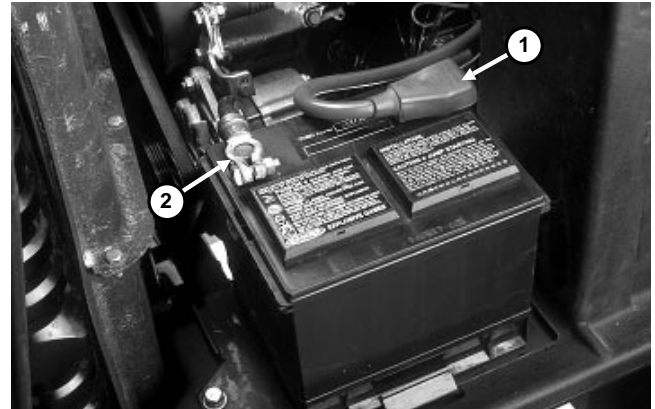


Figure 32

- 1. Positive (+) terminal
- 2. Negative (-) terminal

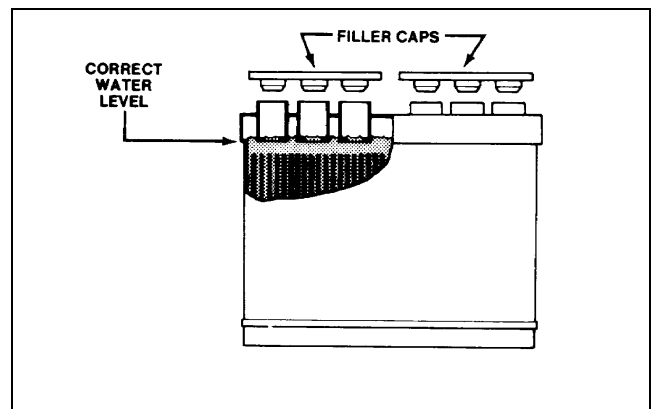


Figure 33

Fuses

The electrical system is protected by twelve (4) fuses located under the control panel to the operator's right.

NOTE: It is not always possible to see if a fuse is faulty. It is recommended that you check for faulty fuses with a continuity tester, not visually.

The starter circuit is also protected by a 30A in-line fuse between the start relay and starter solenoid (S/N 59999 and below). The alternator charging circuit is protected by a 80A in-line fuse (S/N 60001 and up).

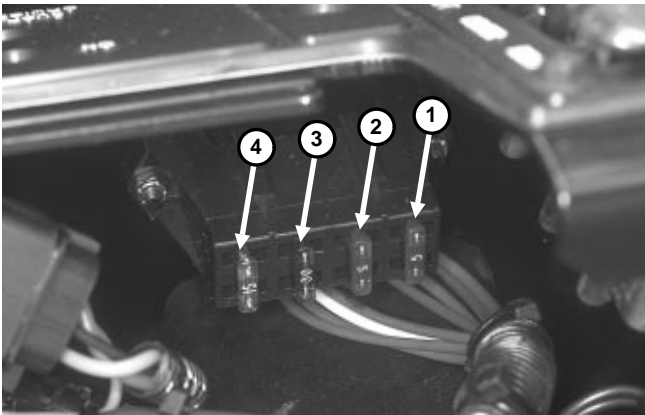


Figure 34

1. ACC fuse
2. RELAY fuse
3. DECK fuse
4. RUN fuse

FUSES	
1. ACC	5A
2. RELAY	5A
3. DECK	30A
4. RUN	15A

## Traction (Neutral) Switch Replacement

1. Remove the two wires that are connected to the traction switch.

2. Have a helper push the traction pedal down into either the FORWARD or REVERSE position; this will take the switch arm tension off of the switch. Loosen two (2) screws and remove the switch.

3. Install new switch. DO NOT over-tighten screws as the switch case could break.

NOTE: Have a helper hold the traction pedal down while installing the switch.

4. Reconnect the two wires to the new switch. Make sure that one wire is connected to the "COMMON" terminal, and one wire is connected to the "NORMALLY OPEN" (N.O.) terminal.

**IMPORTANT:** The traction switch has three (3) terminals. If the two (2) wires are not connected to the "COMMON" and "NORMALLY OPEN" (N.O.) terminals, the engine will be unable to start and the safety interlock circuit will not function properly.

NOTE: Apply "Loctite 271" or equivalent to threads of switch screws before installing.



### CAUTION

If the wires are not correctly installed to the switch, the engine could start with the traction pedal in forward or reverse.

5. Coat the switch terminals and wires with skin-over grease.

6. Check traction control neutral adjustment. (See Traction Control Neutral Adjustment in the Adjustments section of Chapter 4 - HYDRAULIC SYSTEM.

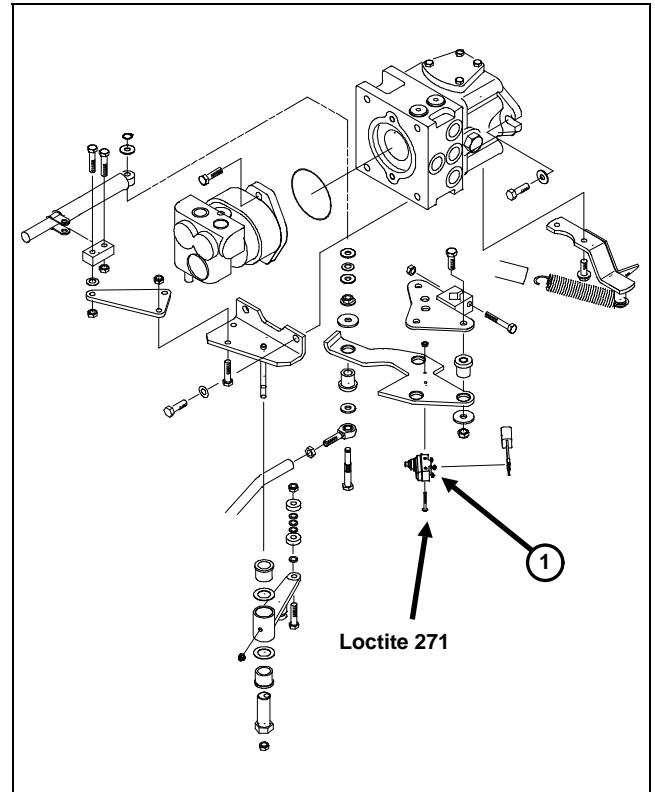


Figure 35

1. Traction (neutral) switch

---

## 4WD Solenoid Coil Replacement

1. Park machine on a level surface, engage parking brake, lower the cutting units and turn engine OFF.
2. Disconnect solenoid electrical connector.
3. Remove coil nut.
4. Remove coil assembly.
5. Install new coil assembly and secure with coil nut. Apply "Locktite 242" or equivalent to threads on end of stem tube before installing nut. Tighten nut to a torque of 15 in-lb. Over-tightening may damage coil nut or cause solenoid valve to malfunction.
6. Connect electrical connector.

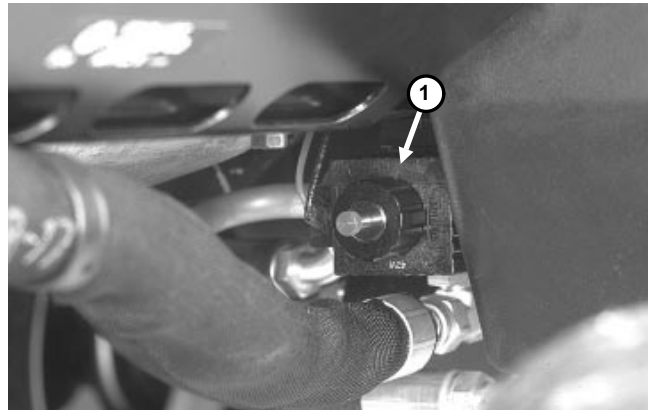


Figure 36

1. 4WD solenoid

---

## Axle Hi/Low Switch Replacement

1. Park machine on a level surface, engage parking brake, lower the cutting units and turn engine OFF.
2. Disconnect Hi/Low switch electrical connector.
3. Remove Hi/Low switch with o-ring, spring & ball guide, spring, plunger and switch pin guide.
4. Before installing new switch, clean spring & ball guide, spring and plunger with cleaning solvent. Replace any worn or damaged parts. After parts are dry, coat spring & ball guide, spring, plunger and inside of switch pin guide with No. 2 multi-purpose grease.
5. Install a new o-ring, then install the new switch.
6. Connect electrical connector.

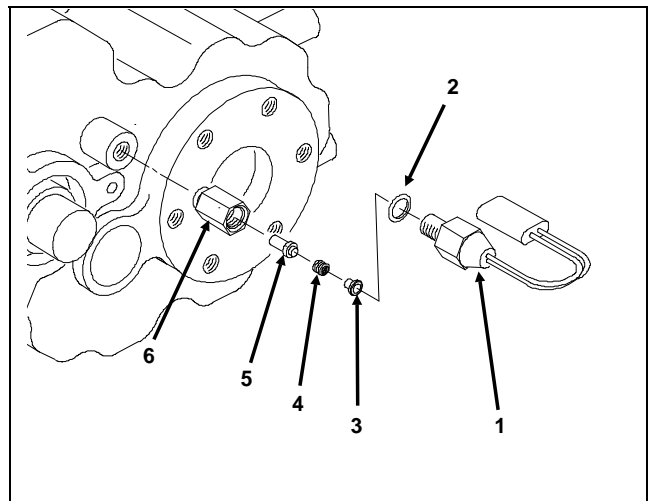


Figure 37

- |                        |                     |
|------------------------|---------------------|
| 1. Hi/Low Switch       | 4. Spring           |
| 2. O-ring              | 5. Plunger          |
| 3. Spring & ball guide | 6. Switch pin guide |

NOTE: For proper operation, the switch must be screwed all the way in. Improper lubrication or debris in the switch could cause the switch to not open and close properly. Shift linkage that is out of adjustment can also cause improper switch operation.

## Wing Switch Replacement

1. Park machine on a level surface, engage parking brake, lower the cutting units and turn engine OFF.
2. Remove deck covers.
3. Disconnect wing switch electrical connector.
4. Remove boot, spring, nut and washer, then remove the wing switch. Disconnect wiring assembly from switch terminals.
5. Install wire assembly on new wing switch. Make sure that one wire is connected to the "COMMON" terminal, and one wire is connected to the "NORMALLY OPEN" (N.O.) terminal.

**IMPORTANT:** The wing switch has three (3) terminals. If the two (2) wires are not connected to the "COMMON" and "NORMALLY OPEN" (N.O.) terminals, the safety interlock circuit will not function properly.



### CAUTION

If the wires are not correctly installed to the switch, the wing deck could operate when in the raised position.

6. Coat switch terminals and wires with skin-over grease.
7. Install new switch. Apply Loctite 242 or equivalent switch threads before installing nut. Tighten nut to a torque of 75 - 100 in-lb. Install spring and boot.

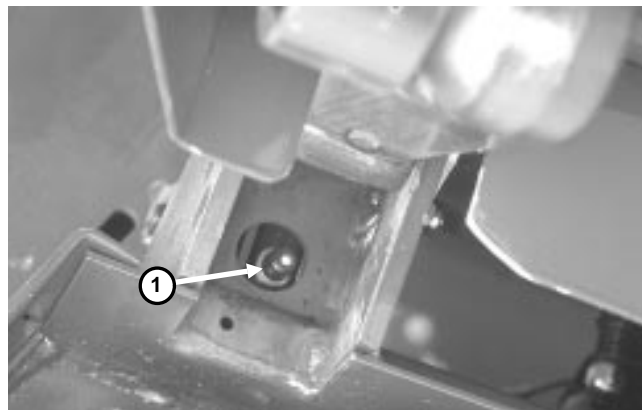


Figure 38

### 1. Wing switch

(Shown from below wing with wing in raised position)

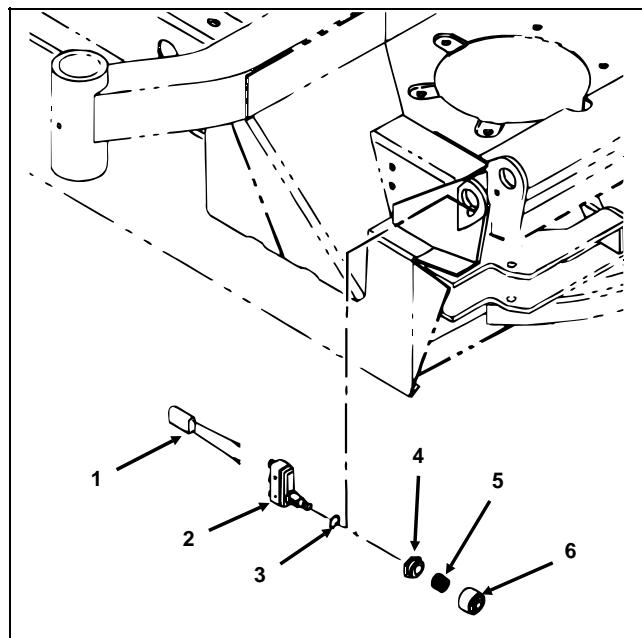


Figure 39

1. Wire assembly
2. Wing switch
3. Washer

4. Nut
5. Spring
6. Boot





# Axles and Brakes

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Axles and Brakes

# Specifications

Item	Specification
Tire pressure	20 PSI front and rear
Wheel bolt torque	85 - 100 ft-lb rear, 45 - 55 ft-lb front
Front axle hub nut torque	300 - 350 ft-lb
Transaxle adapter plate screw torque	65 ft-lb
Front axle housing cap screw torque	100 ft-lb
Rear wheel toe-in	0.25 in.
Service brake adjustment	1.5 in. "free travel" in pedal
Front axle lubricant	SAE 80-90W EP gear lube 144 oz. (4.5 U.S. qt.) capacity
Rear 4WD axle lubricant	SAE 80-90W EP gear lube 80 oz. (2.5 U.S. qt.) capacity

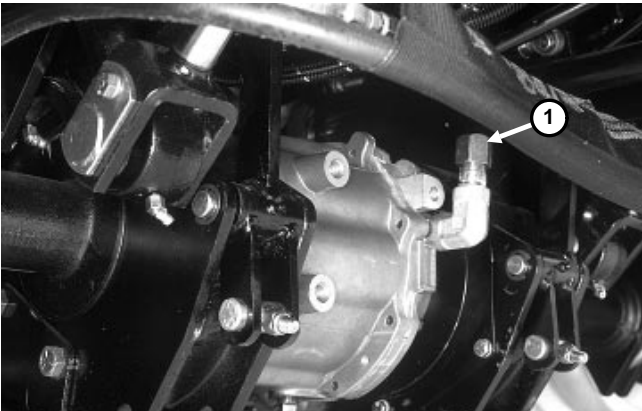


Figure 1

1. Front axle dipstick cap

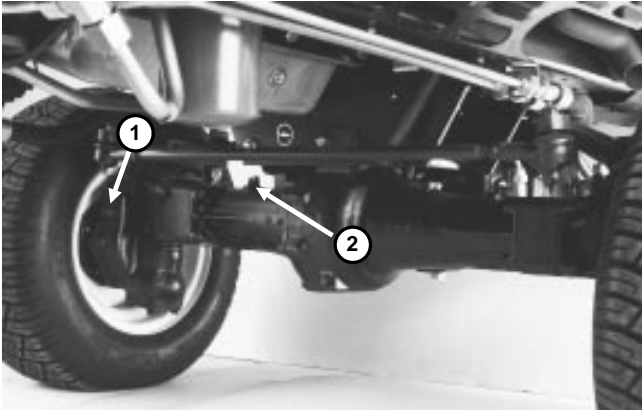


Figure 2

1. Rear axle check plug      2. Rear axle fill plug



# General Information

## Four-Matic™ 4WD Over-Running Clutch Operation

There are two hydraulic drive motors on the Groundsmaster 455-D, 4WD; one for the front axle and one for the rear axle. The drive for the rear axle incorporates an OVER-RUNNING (ROLLER) CLUTCH THAT TRANSMITS POWER ONLY IN THE FORWARD DIRECTION (Fig. 3).

Front and rear axle gear ratios and tire sizes were carefully selected so that during normal operation, the REAR AXLE SHAFT TURNS SLIGHTLY FASTER THAN THE REAR AXLE MOTOR.

Any time the front wheels begin to slip (such as when climbing a steep hill), the forward movement of the traction unit slows. This causes the rear axle shaft speed to slow down. As soon as the rear axle shaft is turning the same speed as the rear motor, the roller clutch will engage and power will be transmitted from the rear motor to the rear wheels – four wheel drive (Fig. 3).

When the traction unit is turning, the rear wheels swing out in a larger arc and must travel faster than the front wheels. In this condition, the rear wheels and axle shaft are turning faster than the rear motor and the roller clutch is disengaged (Fig. 4).

NOTE: The Four-Matic four wheel drive system may not operate properly if the tires are replaced by different size tires, or if proper tire pressure is not maintained.

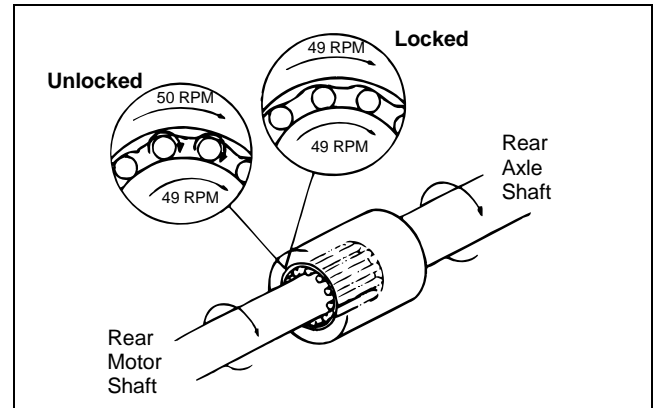


Figure 3

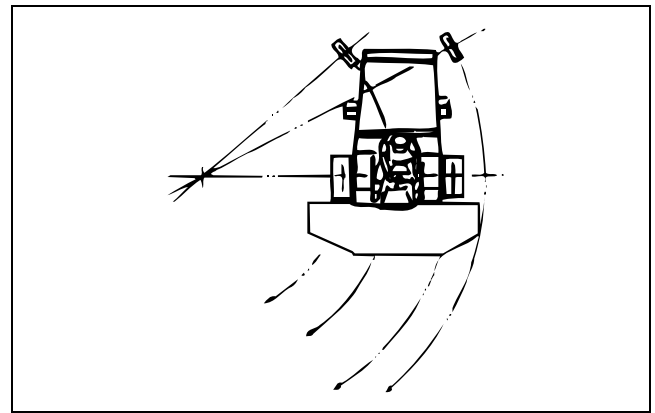


Figure 4

# Special Tools

Order special tools from the *TORO SPECIALS TOOLS AND APPLICATIONS GUIDE (COMMERCIAL PRODUCTS)*.

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## Rear 4WD Axle Tools

### TOR4030 – Differential Case Gauge

Used to determine the number of shims required between the 4WD rear axle differential housing.

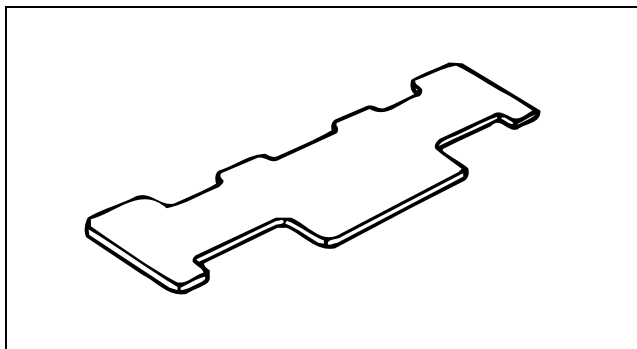


Figure 5

### TOR4039 – Pilot Bushing Driver

Used to install the pilot bushing into ends of 4WD rear axle.

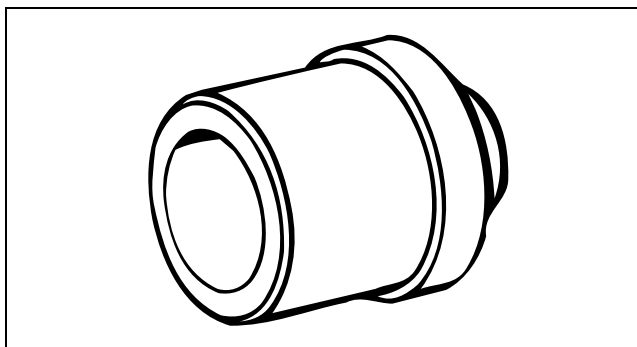


Figure 6

### TOR4040 – Pinion Nut Tool

Used to remove or install the pinion (sleeve) nut on the 4WD rear axle.

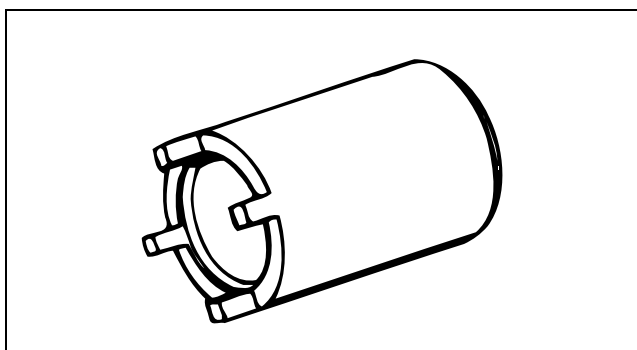


Figure 7

#### **TOR4041 – Bevel Gear Remover**

Used to separate the bevel gears from their shafts in the ends of the 4WD rear axle.

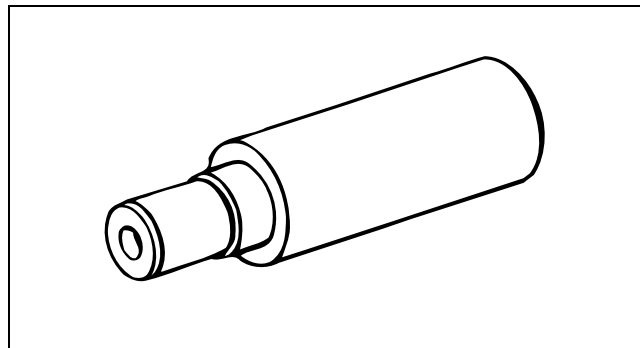


Figure 5

#### **TOR4042 – Pinion Gauge**

Used to determine the number of shims required to properly position the 4WD rear axle pinion.

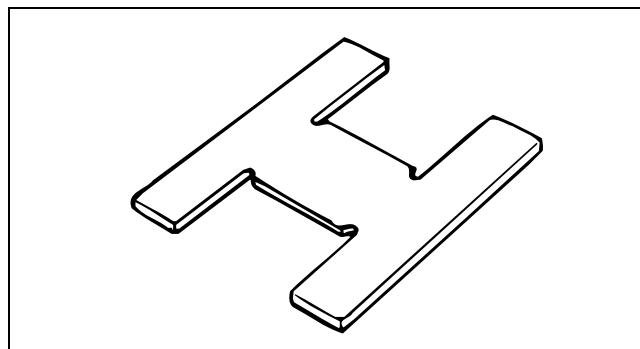


Figure 6

#### **TOR4043 – Oil Seal Installation Tool**

Used to install the oil seals in the ends of the 4WD rear axle.

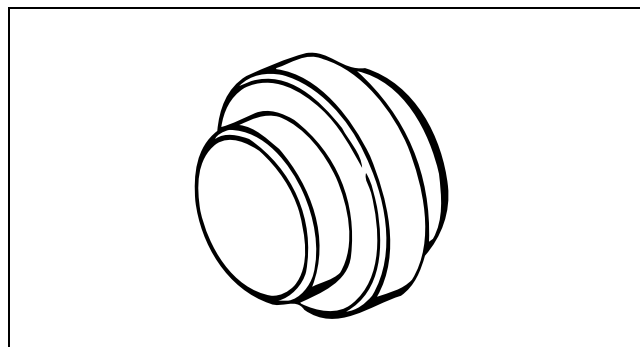


Figure 7

# Adjustments

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## Brake Adjustment

Adjust service brakes when there is more than 1.5 in. “free travel” of brake pedal, or when brakes do not work effectively. Free travel is the distance the brake pedal moves before braking resistance is felt.

To reduce free travel of brake pedals, tighten nut on brake rod adjuster, 1/2 turn at a time, until you get desired “free travel” in pedal.

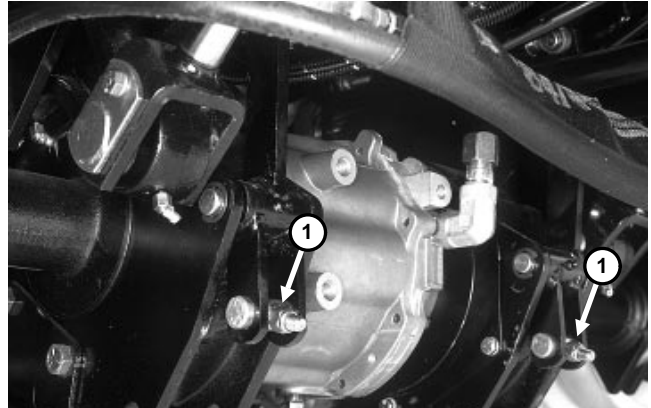


Figure 11

1. Brake rod adjuster

---

## Rear Axle Toe-in Adjustment

1. Measure center-to-center distance (at axle height) at front and rear of steering tires. Front measurement must be 1/4 in. less than rear measurement.

2. To adjust, loosen clamps at both ends of tie rods.

3. Rotate tie rod to move front of tire inward or outward.

4. Tighten tie rod clamps when adjustment is correct.

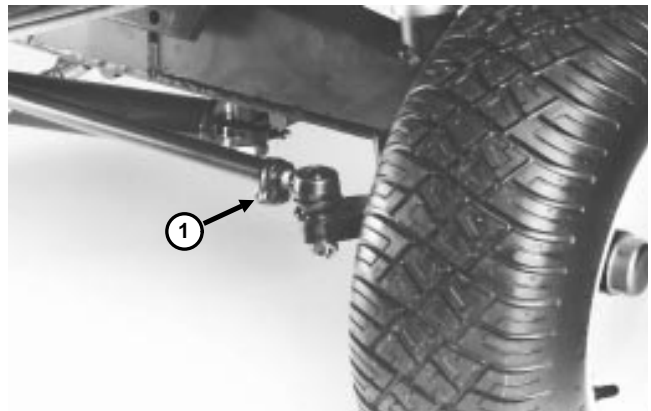


Figure 12

1. Tie rod clamps

## Transaxle Shift Linkage Adjustment

1. Remove steering tower cover.

2. Move axle shift lever forward to transport (high speed) position. Measure shaft dimension from side of transaxle case to end of shaft (Fig. 13). Adjust upper linkage length at top eye rod if necessary to get proper dimension (Fig. 14).

3. Move axle shift lever rearward to mow (low speed) position. Measure shaft dimension from side of transaxle case to end of shaft. Adjust linkage length at top eye rod if necessary to get proper dimension.

4. Move axle shift lever forward to transport (high speed) position and verify that the dimension is correct.

5. Move axle shift lever rearward to mow (low speed) position. Start the engine and with decks in down position turn on PTO engagement switch. The cutting unit should engage. When axle shift lever is moved to N or transport position, the cutting unit should disengage. If the cutting unit does not disengage there is a problem in the axle hi-low switch circuit (see Chapter 5 - Electrical System).

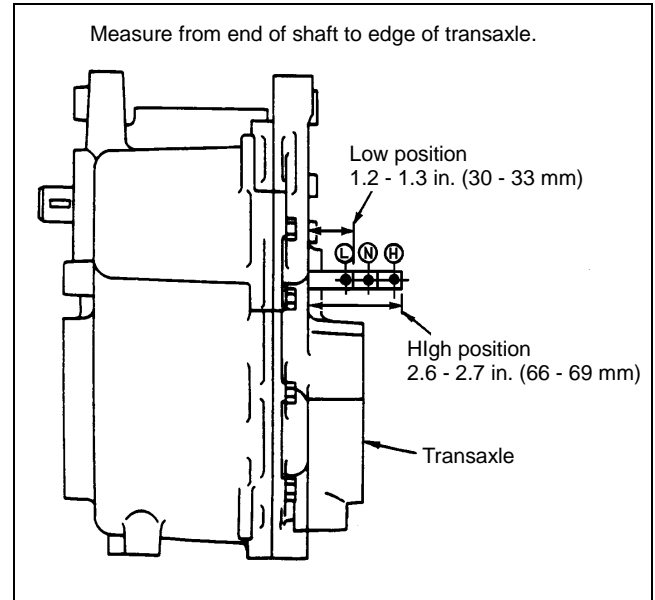


Figure 13

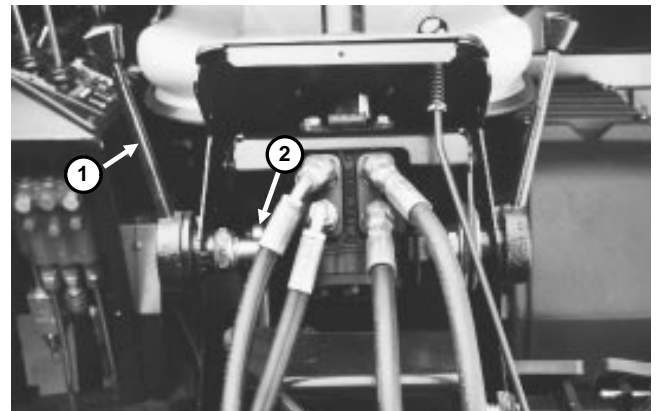


Figure 14

1. Axle shift lever

2. Upper linkage

# Repairs

## Wheel Bearing Service (2WD Rear Axle)

1. Jack up rear of machine until tire is off the floor. Support machine with jack stands or blocks to prevent it from falling.
2. Remove dust cap from end of wheel spindle.
3. Remove cotter pin, slotted nut and washer. Slide wheel off of spindle shaft.
4. Pull seal out of wheel hub.
5. Remove bearings from both sides of wheel hub. Clean the bearings in solvent. Make sure the bearings are in good operating condition. Clean the inside of the wheel hub. Check the bearing cups for wear, pitting or other noticeable damage. Replace worn or damaged parts.
6. If bearing cups were removed from the wheel hub, press them into the hub until they seat against the shoulder.

7. Use No. 2 general purpose lithium base grease containing E.P. additive. Pack both bearings with grease. Install one bearing into the cup on inboard side of wheel hub. Lubricate the inside of the new lip seal and press it into the wheel hub.

**IMPORTANT: The lip seal must be pressed in so it is flush with the end of the hub. The lip of the seal must be toward the bearing.**

8. Pack inside of wheel hub with some grease (not full). Install remaining bearing into bearing cup.
9. Slide the wheel onto the spindle shaft and secure it in place with the flat washer and slotted nut. DO NOT tighten the nut or install the cotter pin.
10. Adjust preload on the wheel bearings (see Adjusting Rear Wheel Bearings).

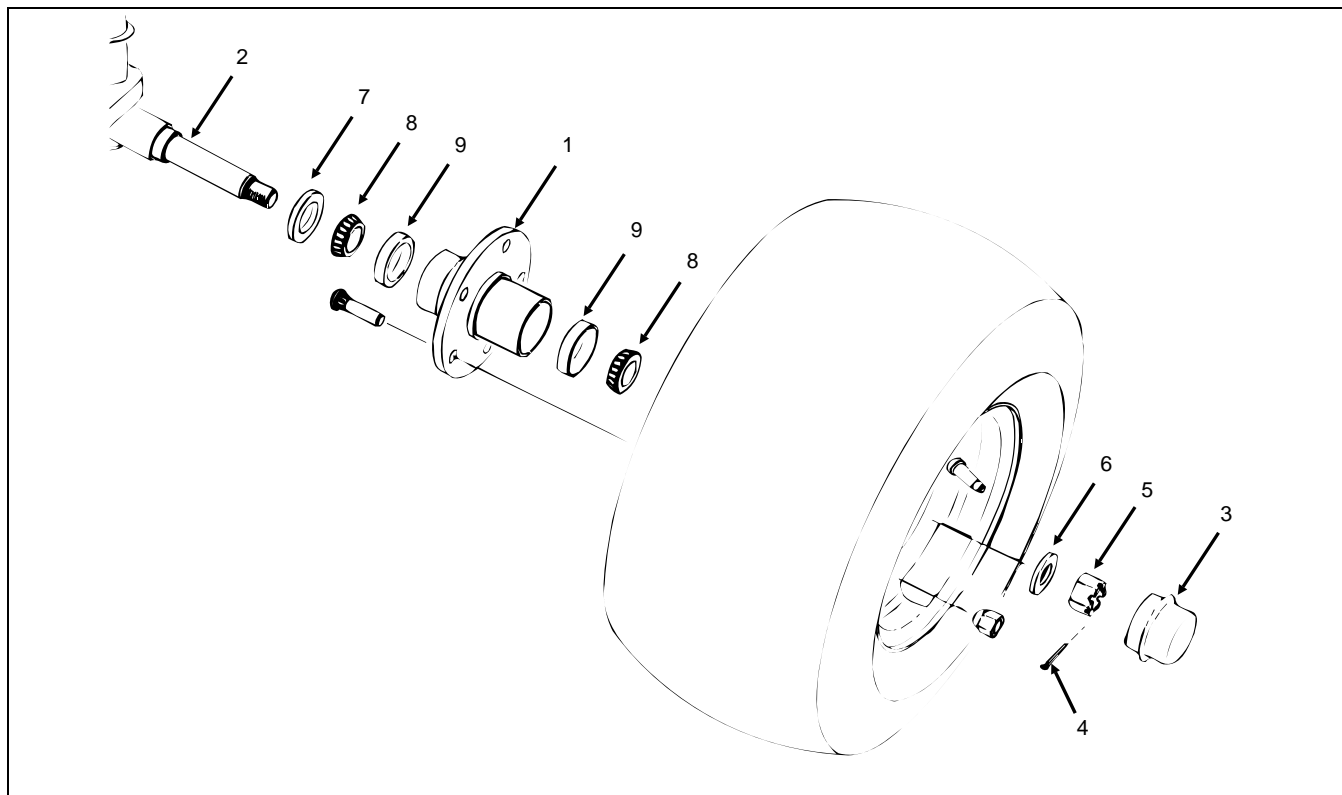


Figure 15

- 1. Wheel hub
- 2. Wheel spindle
- 3. Dust cap

- 4. Cotter pin
- 5. Slotted nut
- 6. Washer

- 7. Seal
- 8. Bearing cone
- 9. Bearing cup

## Adjusting Rear Wheel Bearings

1. Remove dust cap from end of wheel spindle. Remove cotter pin retaining slotted nut in place.

2. Rotate the wheel by hand and tighten the slotted nut until the bearing binds SLIGHTLY. Then, loosen the nut until the nearest slot and hole in the spindle line up. Reinstall the cotter pin to retain the slotted nut in place. NOTE: The correct end play of the adjusted assembly is 0.002 - 0.005 inches.

3. Remove jack stands or blocks and lower machine to floor.

4. Put a coating of grease on the inside of the dust cap. Install dust cap on end of wheel spindle.



Figure 16

1. Cotter pin and slotted nut

Front Axle Removal and Disassembly

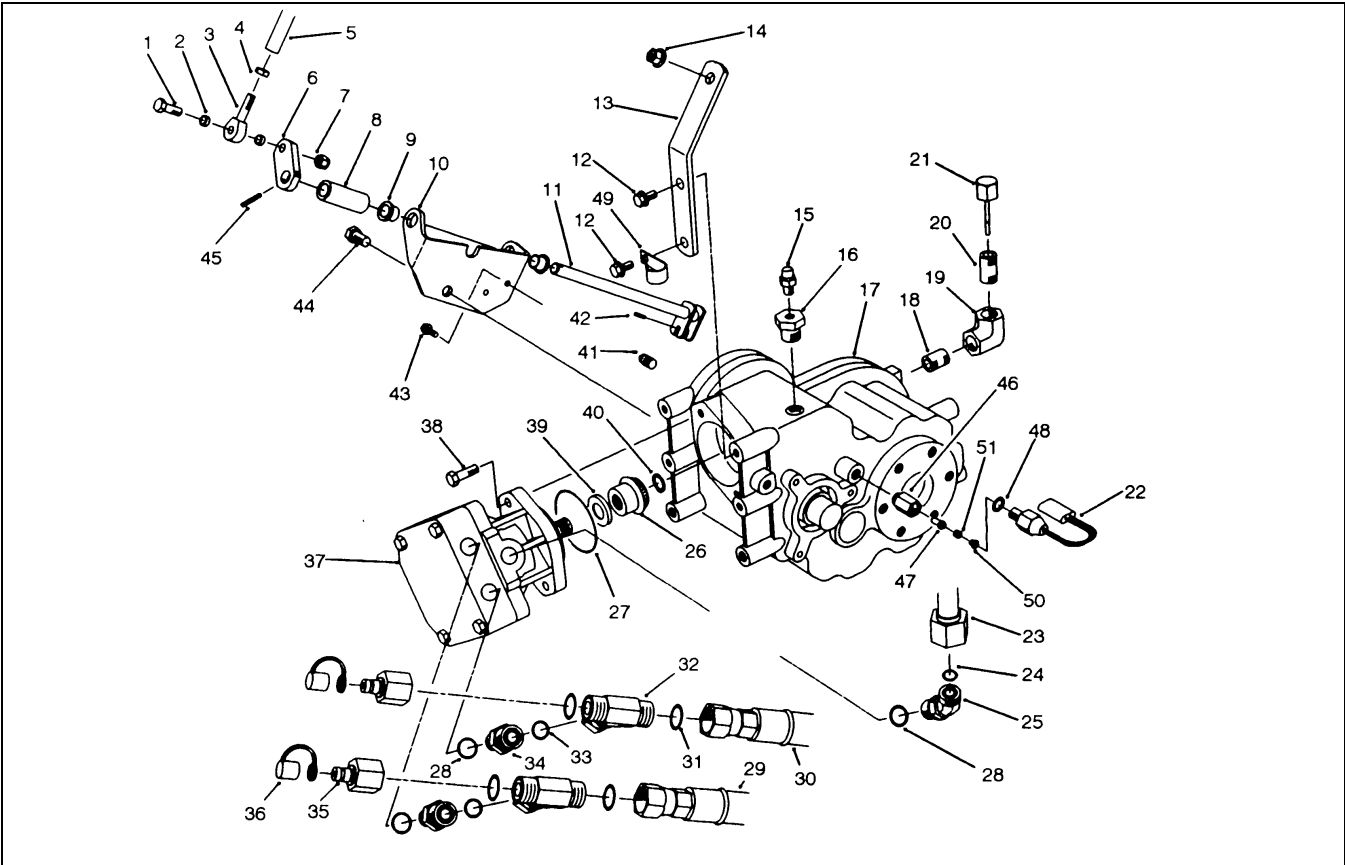


Figure 17

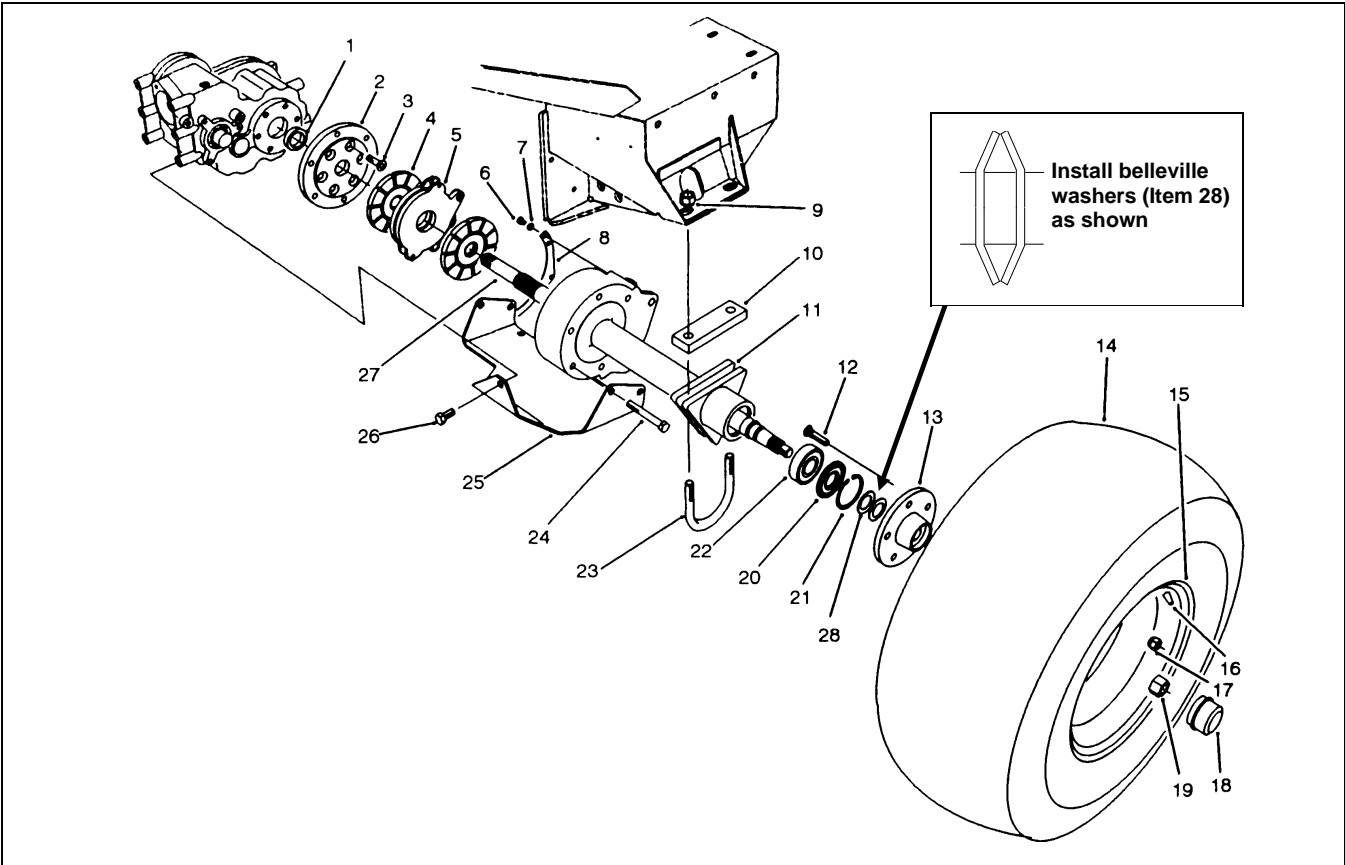


Figure 18



## Front Axle Removal

1. Drain oil from transaxle.
2. Jack up front of machine and support chassis frame with jack stands.
3. Remove front wheels. Remove nuts (Fig. 18, Item 19). Use a puller to pull each wheel hub (Item 13) off of shafts. Remove belleville washers (Item 28).
4. Remove roll pin (Fig. 17, Item 42). Remove cap-screws (Item 43, 44) securing shift rod support (Item 10) to transaxle. Remove hex flange head screws (Item 12) securing transaxle support bracket (Item 13) to transaxle.
5. Clean all exterior surfaces of axle and transaxle.
6. Remove capscrews (Fig. 18, Item 38) and disconnect hydraulic motor (Item 37) from transaxle. DO NOT disconnect hoses from hydraulic motor.
7. Disconnect brake linkage rod eyes from brake linkage arms. NOTE: Brake linkage is spring loaded.
8. Disconnect and put covers on hydraulic lines that run under axle assembly or that go through bulkhead brackets connected to axle assembly. Mark hydraulic lines for proper reassembly.
9. Support axle assembly, then remove U-bolts (Fig. 18, Item 23) securing axle to frame.
10. Carefully lower and pull axle assembly out from under machine.

## Front Axle Disassembly

1. Remove skid plate (Fig. 18, Item 25).

NOTE: Before removing axle housings, scribe alignment marks across transaxle housing, adapter plate and axle housing for proper reassembly.

2. Remove remaining capscrews securing axle housing (Item 11) to transaxle and carefully pull axle housing and shaft (Item 27) away from transaxle.
3. Remove axle housing cover (Item 8).
4. Remove cotter pin and clevis pin to disconnect brake clevis from brake actuator.

5. Remove brake disks (Item 4) and brake actuator (Item 5).

6. Remove adapter plate (Item 2) and transaxle spacer (Item 1).

7. To remove axle from housing, remove retaining ring (Item 21) from outboard end of housing, then tap lightly with a mallet from inside out. A seal ring (Item 20) and a pressed on, sealed ball bearing (Item 22) will be on the end of the axle.

8. Do steps 2 - 7 for axle housing on other side.

## Front Axle Assembly

Reverse steps 1 - 8 under Front Axle Disassembly.

To install axle assemblies into transaxle case, grease axle spline ends heavily. Push axle through seal. Use caution to prevent damage to seal when axle splines are going through seal.

## Front Axle Installation

Reverse steps 1 - 10 under Front Axle Removal.

If a new transaxle is installed, determine correct shim to use behind spiral bevel gear on hydraulic motor by subtracting actual motor flange face to sleeve dimension from dimension stamped on transaxle or attached to tag.

Dimensional Range	Pinion Shim
2.6000 - 2.6155	0.038 (82-5390)
2.6156 - 2.6225	0.045 (82-5380)
2.6226 - 2.6400	0.052 (82-5400)

## After Assembly

1. Fill transaxle with approximately 144 oz. (4.5 U.S. qt.) of SAE 80-90W EP gear lube.
2. Check for hydraulic oil leaks.
3. Check adjustment of transaxle shift linkage.
4. Check brake "free play" adjustment.

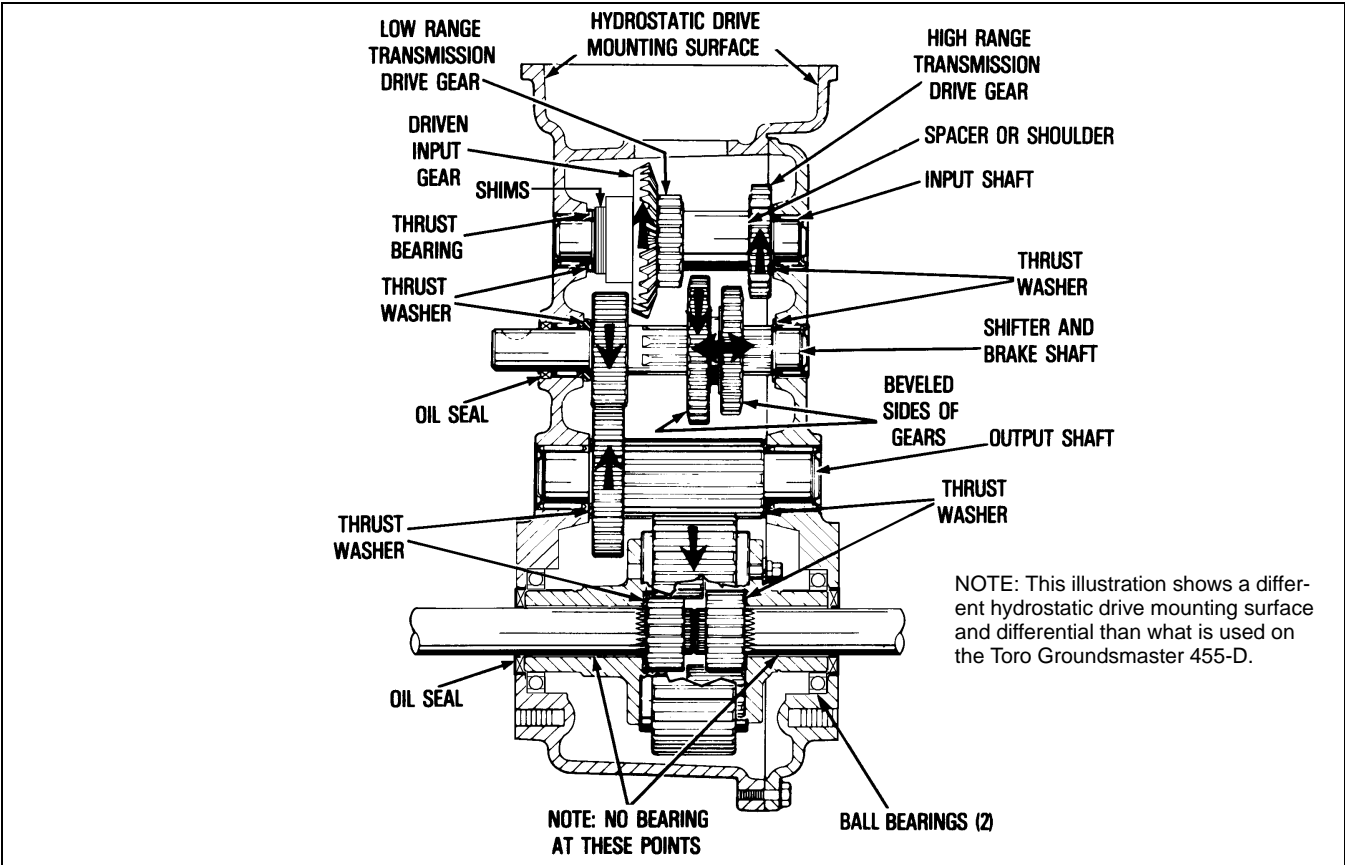


Figure 19

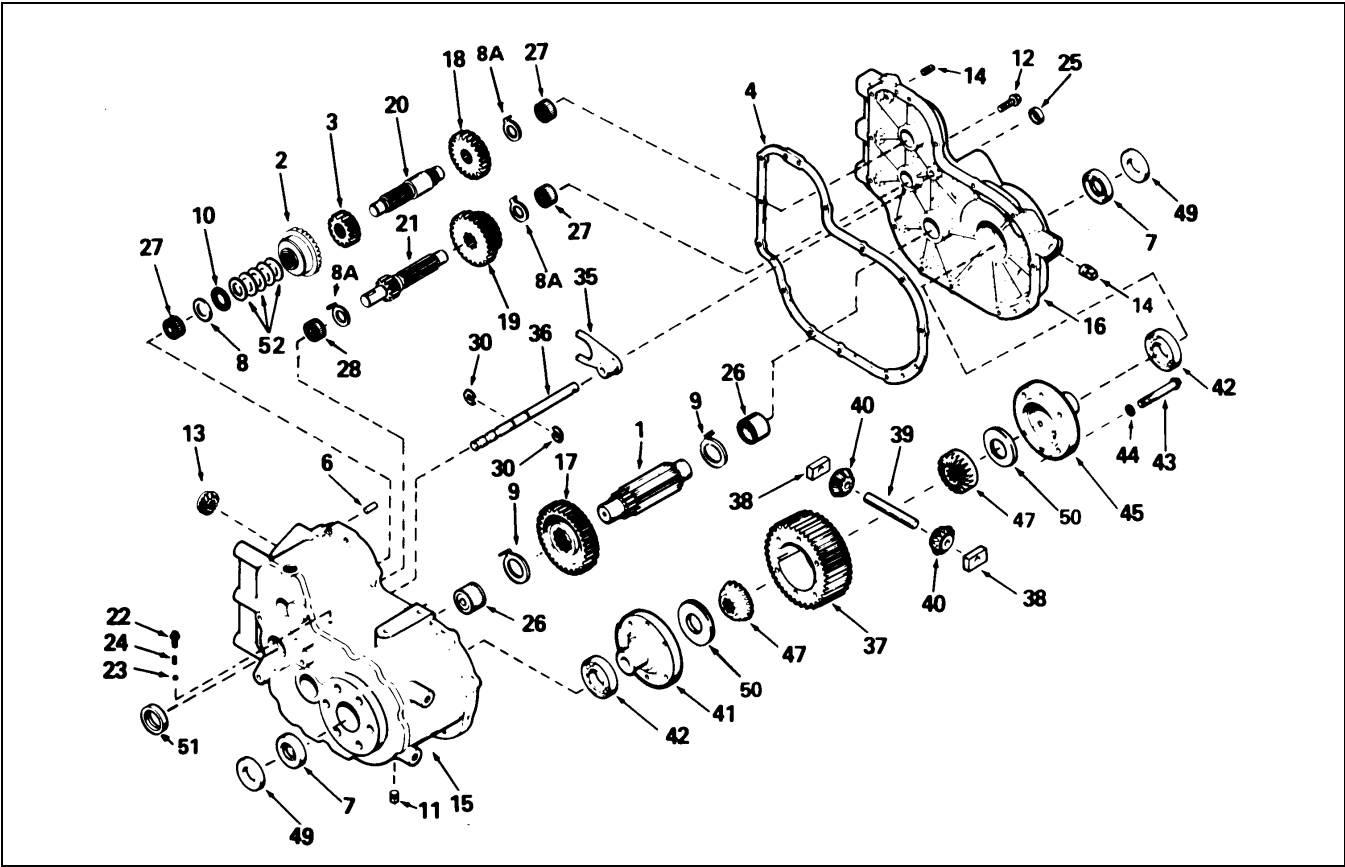


Figure 20

## Transaxle Disassembly

1. Clean all exterior surfaces of transaxle.
2. Put the transaxle on a work bench with cover side up. Remove screws. Lift cover (Fig. 20, Item 16) off and discard gasket (Item 4).
3. Remove differential assembly and thrust washers (Item 8A and 9).
4. Remove large drive gear (Item 18) from input shaft bevel gear assembly.
5. Before removing shifter rod and fork, the bolt (Item 22), spring (Item 24) and ball (Item 23) should be removed at the outside of the case.
6. Remove shifting rod (Item 36), fork (Item 35) and shifter gears (Item 19).
7. Remove output shaft assembly.
8. Remove shifter / brake shaft assembly.

## Inspection

1. Check case and cover for leaks or cracks.
2. Remove and discard all oil seals. Do not replace seals until unit is reassembled.
3. Inspect needle bearings and replace if necessary.  
  
Use an arbor press and properly sized tool to remove and install needle bearings. When installing bearings, apply pressure to bearing from stamped side. Bearings should be pressed in 0.015 to 0.020 in. below the thrust surface.
4. Check gear teeth for wear, pitting or breakage.
5. Inspect bearing surfaces for smoothness.
6. Inspect gears and shafts for out of round.
7. Splines should allow a smooth fit. Rotate meshing parts for a better fit if binding seems excessive.
8. Check shift detent spring for tension and ball for wear.
9. Check shifter rod grooves for wear. Be sure snap ring sharp edges go away from shifter fork.
10. Inspect shifter fork for straightness and wear.
11. Check differential for loose or damaged parts.
12. Check differential carrier ball bearings for wear and smoothness of rotation and replace if necessary.

## Transaxle Assembly

Reverse steps 1 - 8 under Transaxle Disassembly, watching out for the following:

1. After shift rod is in position, install ball, then spring and bolt. Turn bolt in until head of bolt contacts case.
2. Be sure that thrust washers and spacers are between every shaft and case and cover.
3. Threads of differential bolts must be coated with standard stud Loctite. Install differential assembly so bolt heads are facing away from gear on output shaft.
4. Install new gasket. It may be helpful to dampen gasket with oil to get it to lie flat.
5. After installing cover, install new brake shaft oil seal (Item 51), shifter rod oil seal (Item 25) and axle shaft oil seals (Item 7).
6. To install axle assemblies into transaxle case, grease axle spline ends heavily. Push axle through seal. Use caution to prevent damage to seal when axle splines are going through seal.
6. Install hi/low interlock switch (Fig. 17, Item 17) into transaxle case if removed.

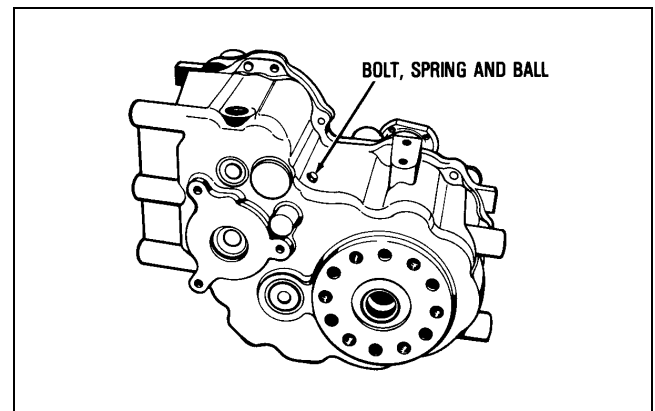


Figure 21

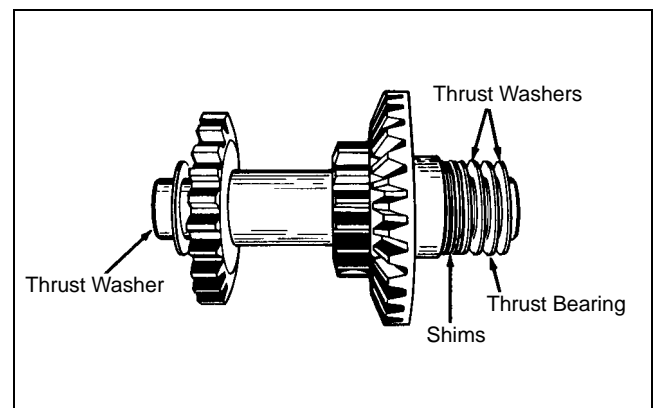


Figure 22

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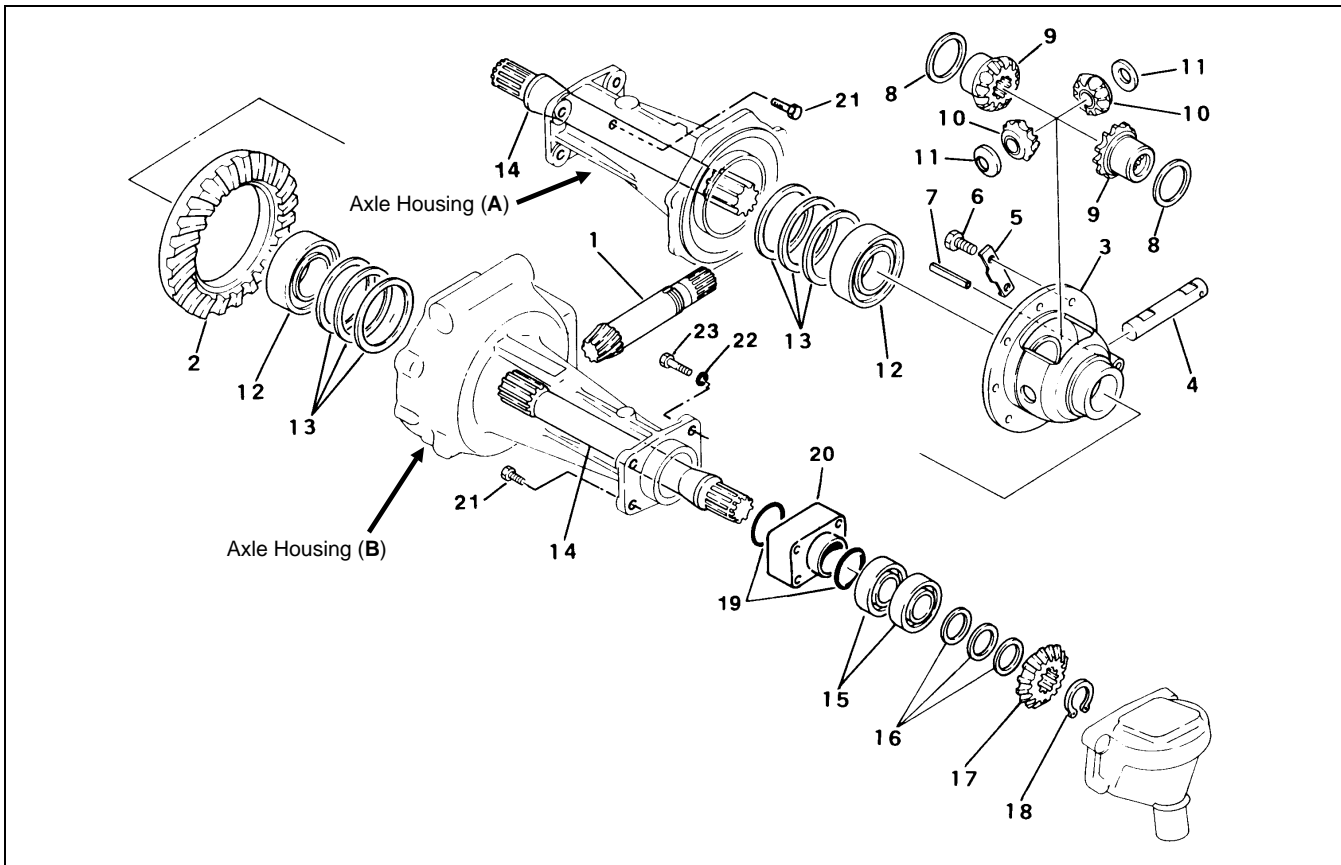


Figure 23

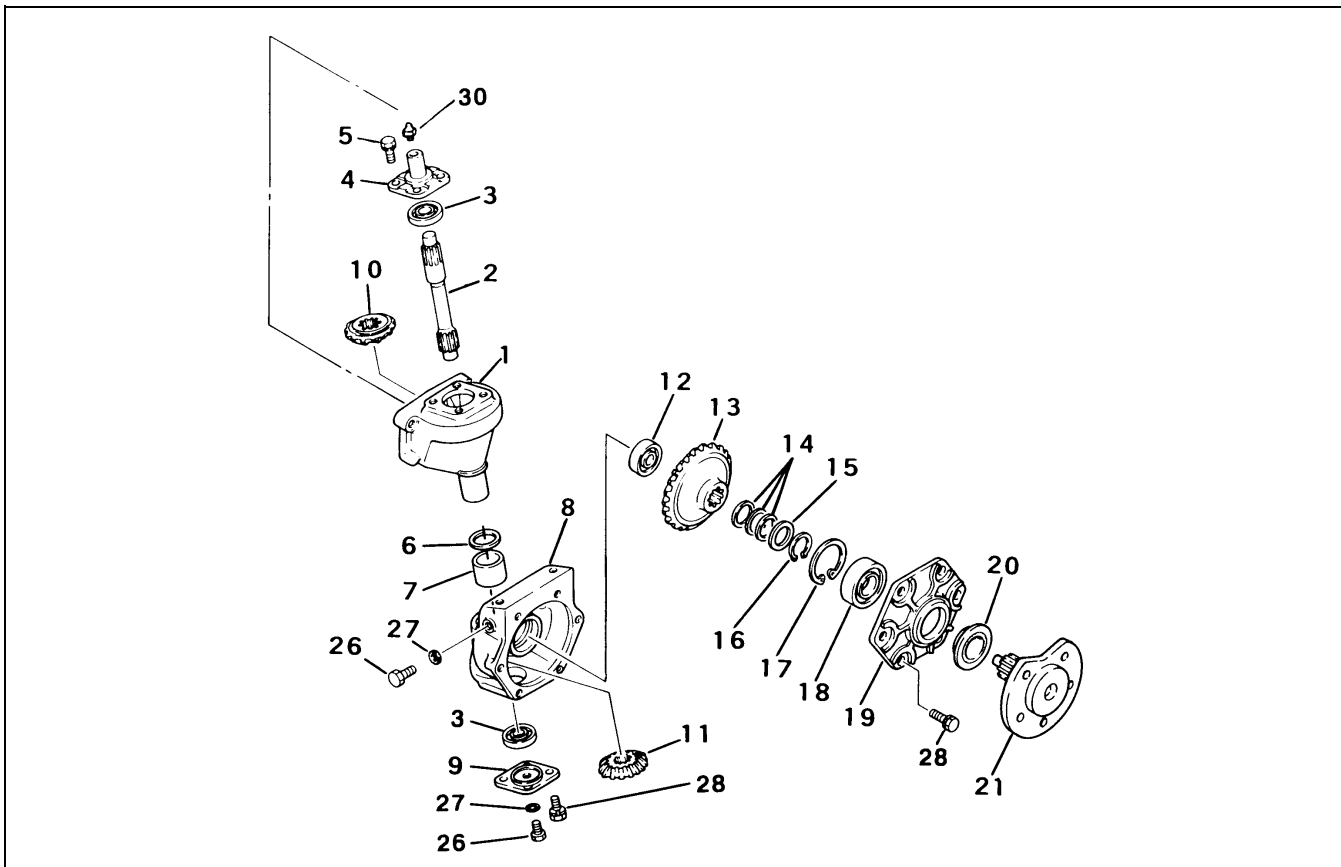


Figure 24

## Disassembly

The two gear cases, right and left can be removed from the housing without requiring the entire axle to be disassembled.

1. Remove tie rod by disconnecting rod end ball joint on each end. Disconnect hydraulic cylinder rod end from drag link arm.

2. Remove bolts (Fig. 23, Item 23 and 21) securing gear case to axle housing and pull gear case complete with final drive case.

NOTE: Of four (4) bolts securing the gear case, the one on the bottom right side (viewed from center of axle) is a reamer bolt (Item 21).

### Disassembling Final Drive Case

1. Remove bearing holder (Fig. 24, Item 19) from final drive case. The holder will come out together with the wheel shaft (Item 21).

2. Pull draglink arm or tie rod arm off final drive case. Be sure to recover the thrust washer.

3. Remove the bolts securing top cover (Item 4) to gear case and remove the cover to expose the top end of final drive shaft (Item 2). Use special tool TOR4041 to drive lightly on the exposed shaft end so that the final drive case will slide off the gear case.

4. Remove bottom cover (Item 9) from final drive case to expose bottom end of shaft. Use special tool TOR4041 to drive the shaft out and take out the 15T bevel pinion (Item 11)).

### Disassembling Wheel Shaft

1. Use a gear puller to draw the bevel gear (Item 13) and ball bearing (Item 12) off wheel shaft.

2. Remove shaft from bearing holder by lightly tapping on the shaft.

3. Remove retaining ring (Item 17) from holder and remove bearing outer race and oil seal (Item 20).

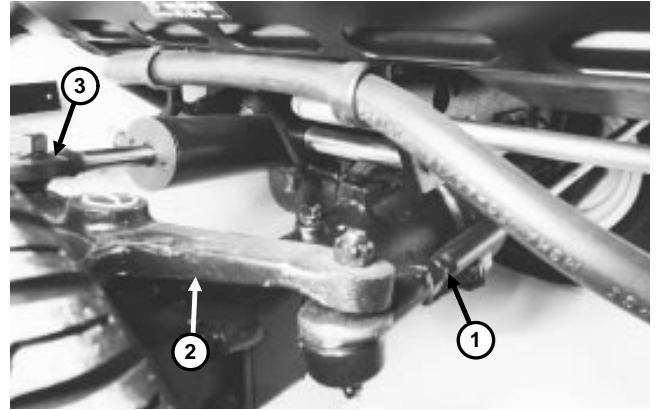


Figure 25

1. Tie rod      2. Drag link      3. Hydraulic cylinder

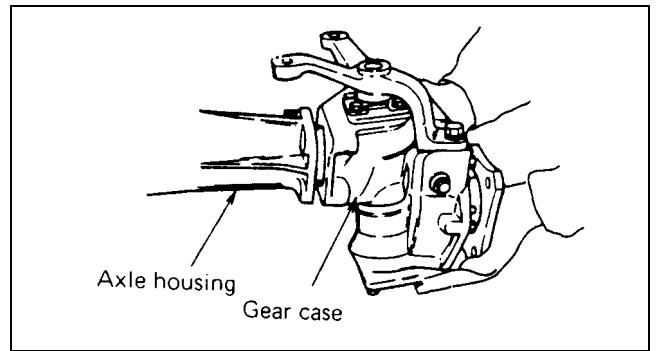


Figure 26

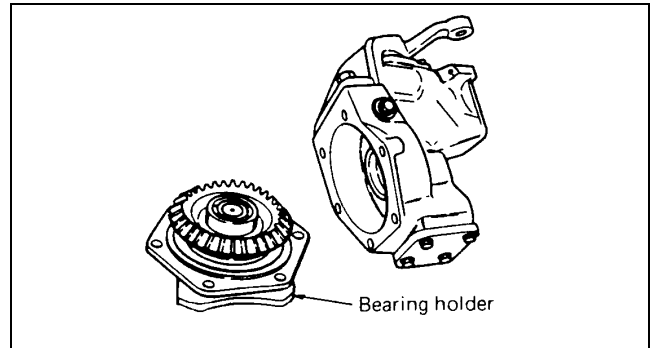


Figure 27

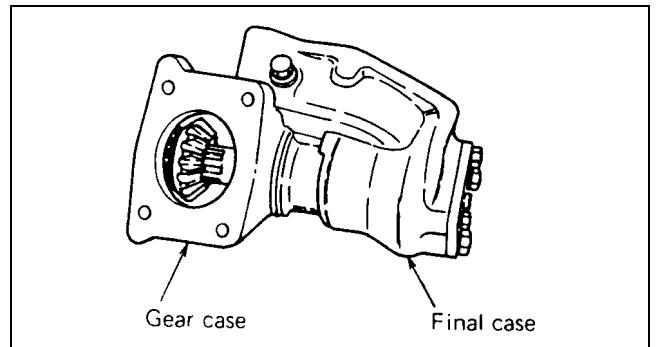


Figure 28

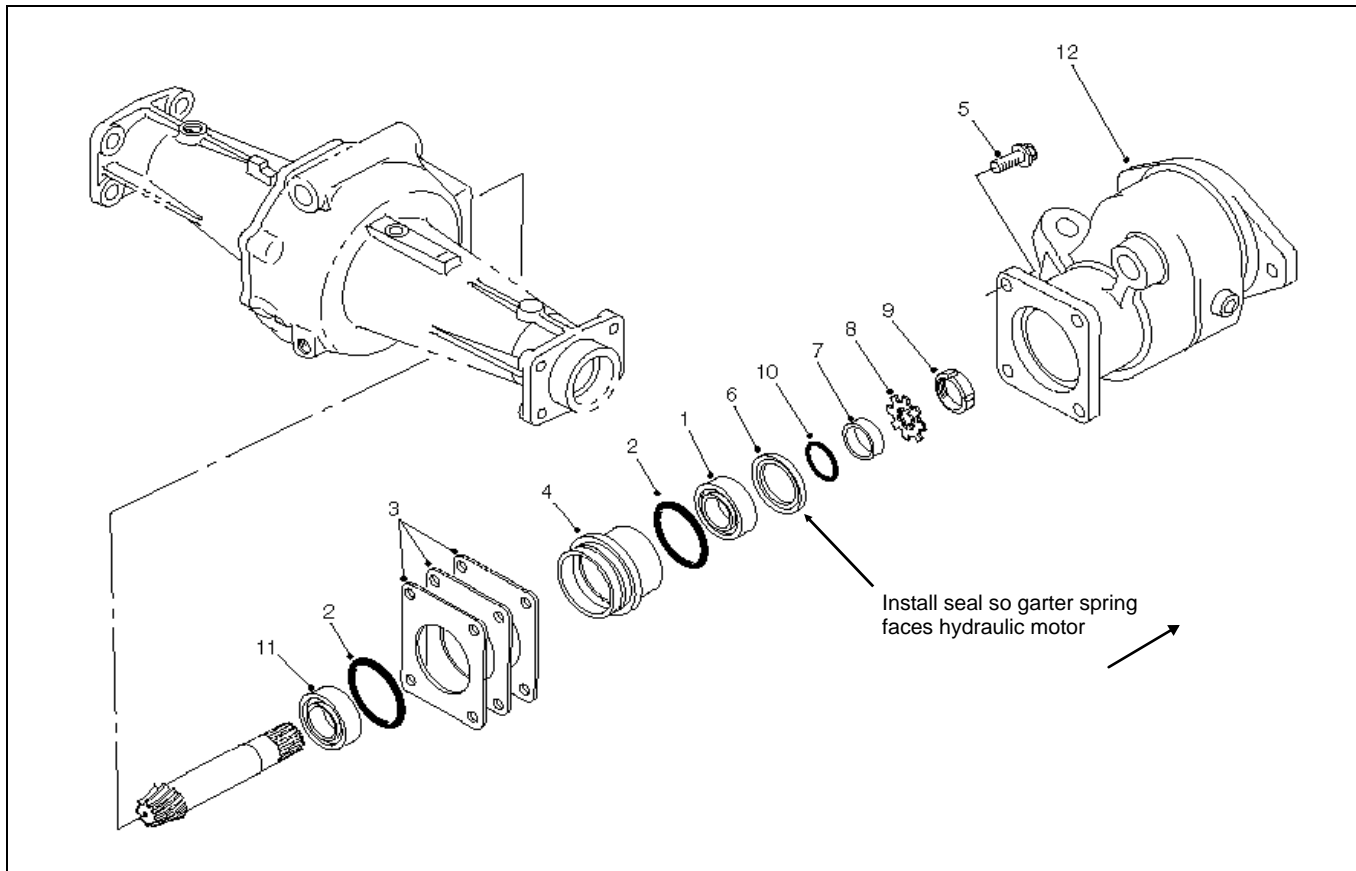


Figure 29

### Disassembling Axle Housing

#### 1. Remove axle from machine before disassembling:

- A. Jack up rear of machine and support from frame with jack stands.
- B. Remove wheels from axle.
- C. Remove hydraulic motor. Do not disconnect hydraulic lines from motor.
- D. Support axle with a jack, then remove axle pivot pin to separate axle from frame.
- E. Pull axle out from under machine and put on a work bench.
- F. Be sure to account for thrust washers between axle pivot and frame.

#### 2. Remove bolts (Fig. 29, Item 5) securing adapter to axle housing and remove adapter.

#### 3. Separate axle housing by removing bolts.

#### 4. Pull out differential shaft (Fig. 23, Item 14) from housing (B).

#### 5. Remove differential gear assembly (Fig. 23, Items 3 - 11) from axle housing (A).

#### 6. Pull out differential shaft from housing (A).

### Disassembling Sleeve Assembly

#### 1. Remove sleeve (Item 4) from adaptor case. Straighten tab washer (Fig. 29, Item 8) and use special tool TOR4040 to remove sleeve (lock) nut (Item 9).

#### 2. Use a press or tap lightly on shaft end to force pinion shaft out of case.

#### 3. Remove oil seal (Item 6) and bearings (Item 1 and 11) as necessary.

## Inspection

Clean the disassembled parts by washing in cleaning solvent. Inspect gears and pinions to be sure their teeth are in good condition. Check to be sure that each bearing rotates smoothly. Examine housings for cracks.

## Reassembly

Replace damaged or worn parts as necessary. Oil or grease the surfaces of rotating or sliding parts before assembling. Grease oil seals and o-rings before installing.

### Assembling Pinion Shaft

1. Fit two outer races of tapered roller bearings into sleeve, positioning each race as shown.
2. Fit inner race of tapered roller bearing to gear side of pinion shaft, pushing it all the way against the pinion shoulder.
3. Insert pinion shaft into sleeve. Fit other inner race to shaft and install o-ring and bushing. Pinion shaft is now securely installed inside the sleeve.
4. Grease oil seal and install it between sleeve and bushing, making outer end face flush with mating face of sleeve. Install seal with garter spring facing toward hydraulic motor.
5. Grease o-ring. Install o-ring, tab washer and lock nut. Tighten lock nut with special tool TOR4040 to specified preload on bearings.

Pinion shaft bearing preload	0.04 ~ 0.06 kg-m (0.29 ~ 0.43 ft-lb)
------------------------------	---

NOTE: Make sure pinion shaft has no end play when checking bearing preload.

6. After obtaining specified preload, secure lock nut by bending tab washer.

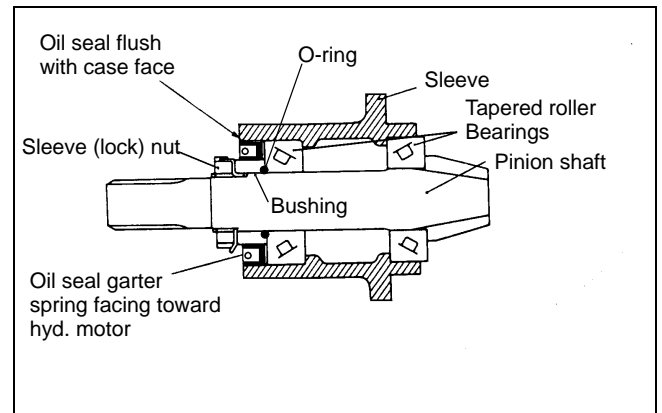


Figure 30

## Adjusting Pinion Shaft Cone Center

“Cone Center” is the distance from the mating face of axle housing to end face of pinion. This distance can be increased or decreased by installing removing shims.

Cone center specification	$43 \pm 0.05\text{mm}$ ( $1.69 \pm 0.002\text{ in.}$ )
---------------------------	---

Shim stock for this adjustment is available in the following thicknesses:

Thickness	Part No.
Shim set	77-4010
0.1 mm (0.004 in.)	76-7410
0.2 mm (0.008 in.)	76-7420
0.4 mm (0.016 in.)	77-7430

Using gauge TOR4042 for cone center adjustment, determine the required thickness of shim by proceeding as follows:

1. Apply grease to o-rings. Install o-rings to sleeve, then install sleeve assembly into adapter case.
2. Put gauge alternately on pinion shaft and select the shim so that with the short gauge, a clearance will occur between the gauge end and case face, but with the long gauge, a similar clearance will occur between the gauge and pinion end face.
3. Apply grease to o-ring and fit to mating face of sleeve. Attach adapter case to axle housing (A) and secure by tightening bolts to proper torque.

Adapter bolt torque	2.5 ~ 3.0 kg-m (18 ~ 22 ft-lb)
---------------------	-----------------------------------

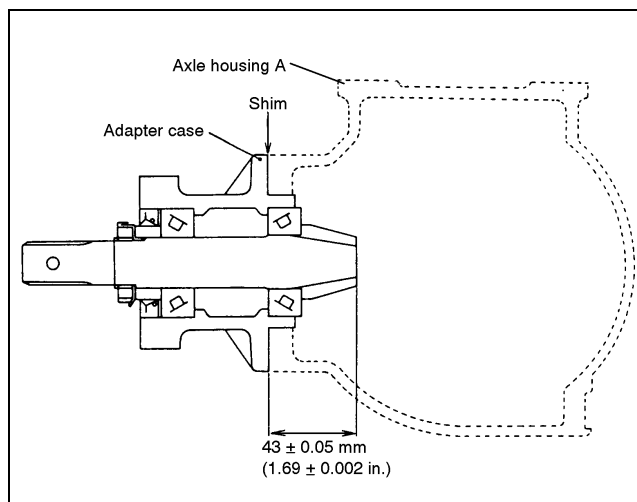


Figure 31

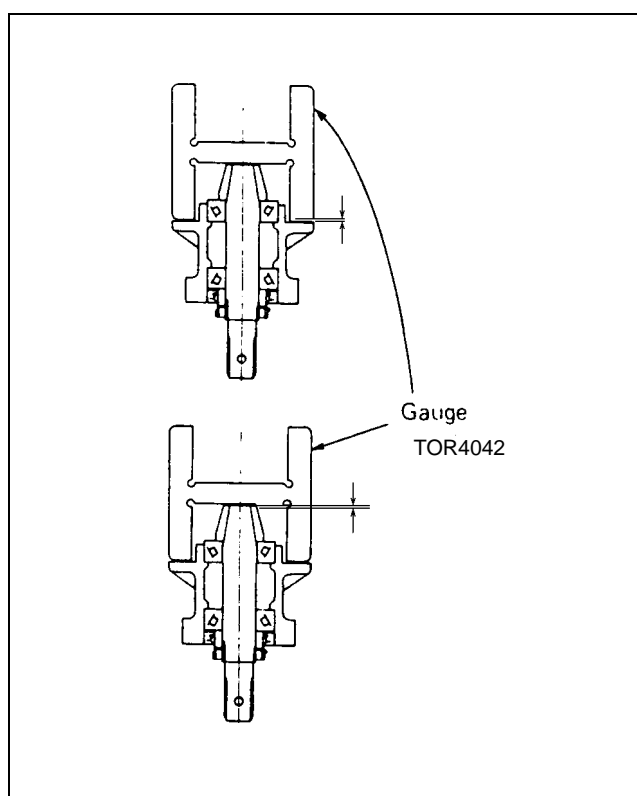


Figure 32



Adjusting Backlash

Backlash specification	0.25 ~ 0.35 mm (0.010 ~ 0.014 in.)
------------------------	---------------------------------------

Adjust shim thickness (between bearing housing of axle housing (A) and bearing) to get specified backlash. Shim stock for this adjustment is available in these thicknesses:

Thickness	Part No.
Shim set	77-4000
0.1 mm (0.004 in.)	76-7290
0.2 mm (0.008 in.)	76-7300
0.4 mm (0.016 in.)	76-7310

Shim Between Differential and Axle Housing (B)

After obtaining specified backlash, determine amount of shims needed:

- 1. Put gauge TOR4038 on axle housing (A) and read clearance (a) between ball bearing and gauge.
- 2. Select from shim stock (shown above for backlash adjustment) to match clearance (a).

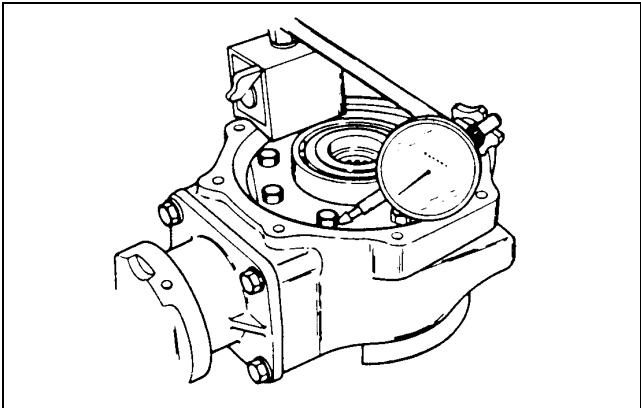


Figure 33

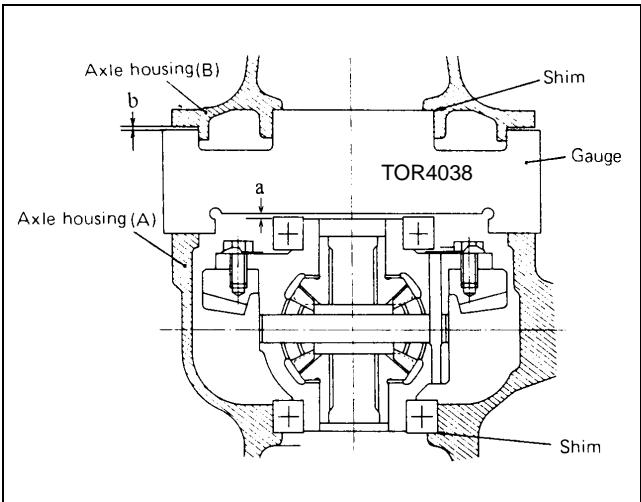


Figure 34

## Assembling Axle Housing

1. Coat mating faces of two housings (A) and (B) with sealant and attach selected shim to face of housing (B). Put the two housings together and fasten them by tightening bolts to following torque value:

Torque specification	2.5 ~ 3.0 kg-m (18 ~ 22 ft-lb)
----------------------	-----------------------------------

2. Fit ball bearings to out end of each differential shaft, then mount pinion (14T) and retain pinion by installing circlip. The ball bearings have a groove cut in the end faces of the inner and outer races. Be sure to position the bearing to its grooved end is on inner side as shown.

3. Install o-rings to spacers. Insert differential shafts through spacers then install differential shaft and spacer to each axle housings.

## Assembling Gear Case and Final Case

1. Use tool TOR4039 to install bushing into final case.

2. Grease oil seal and use tool TOR4043 to carefully fit it to final case, making sure the seal is properly aligned.

NOTE: The steel part of this oil seal is so thin that the seal can distort at the time of installation.

3. Insert final drive shaft into gear case, bringing its large diameter end to top side and fitting pinion (14T) onto splined end. Install inner race of upper tapered roller bearing as shown.

4. Fit bearing out race into gear case. Apply sealant to mating face of holder and secure to case by tightening bolts to following torque value:

Torque specification	2.5 ~ 3.0 kg-m (18 ~ 22 ft-lb)
----------------------	-----------------------------------

NOTE: Be sure to wrap each bolt with sealing tape before installation.

5. Attach final case to gear case while fitting pinion (15T) onto splined end of shaft.

6. Install tapered roller bearing. Apply sealant to mating face of cover and secure cover to final case. Tighten bolts to above listed torque value:

7. Wrap drain plug with sealing tape and install in bottom cover.

8. Turn final case around gear case by hand and check for smooth rotation.

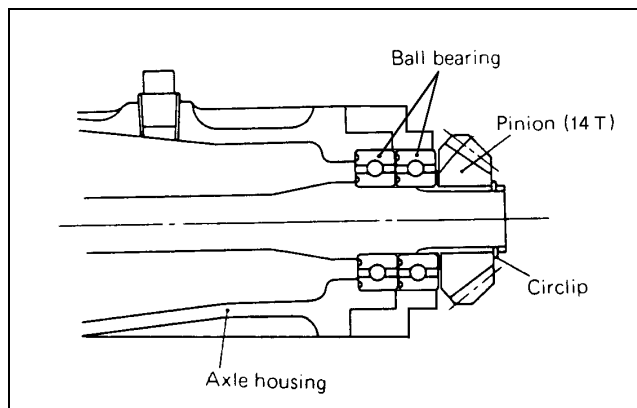


Figure 35

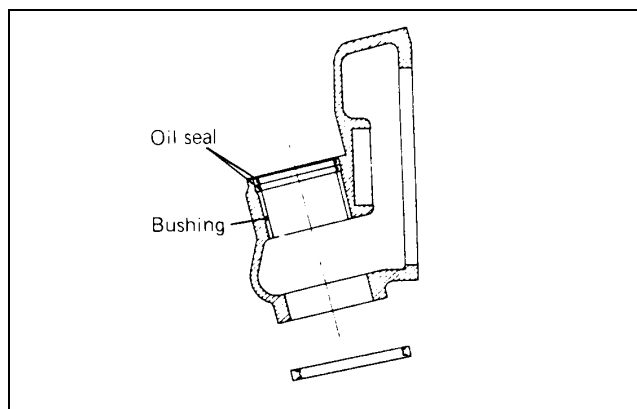


Figure 36

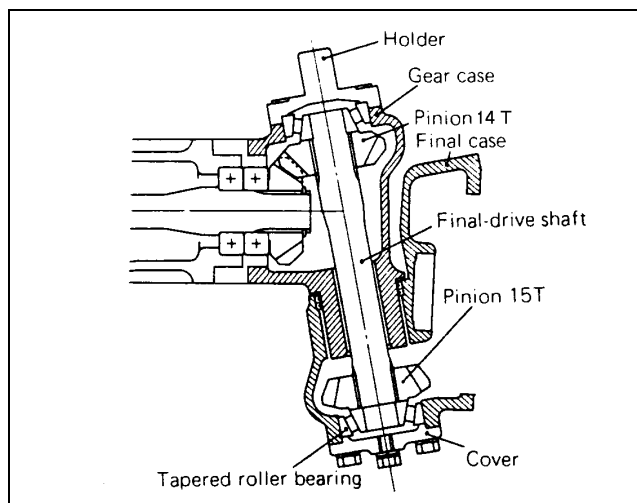


Figure 37

## Installing Drag Link and Tie Rod Arm

1. Carefully insert bushing into arm.
2. Put arm into position over holder, fitting it to final case and secure to case with bolts.
3. Check thrust clearance. Proper thrust clearance is 0 to 0.2 mm (0.008in.). If necessary reduce clearance to specification by shimming. Shim stock for this adjustment is available in the following thicknesses:

Thickness	Shim Part No. TIE ROD ARM	Shim Part No. DRAG LINK ARM
Shim set	77-4050	77-4040
0.8 mm (0.03 in.)	76-7820	76-7700
1.0 mm (0.04 in.)	76-7970	76-7760
1.2 mm (0.05 in.)	76-7980	76-7780
1.4 mm (0.055 in.)	76-7990	76-7790

4. After selecting required shim, remove the arm. Apply multi-purpose lithium base grease to OD part of holder. Install holder on arm with shim and secure to final case by tighten reamer bolts to following torque value:

Torque specification	8.5 ~ 9.5 kg-m (61 ~ 69 ft-lb)
----------------------	-----------------------------------

## Installing Gear Case Assembly to Axle Housing

1. To check backlash between pinions (14T) — one on final drive shaft and one on differential shaft — temporarily fit gear case to axle housing and tighten two bolts diametrically opposite. DO NOT use black reamer bolt for this temporary assembly.
2. Install a dial indicator to final case, putting gauge spindle to tooth on pinion (15T pinion on bottom end of final drive shaft). Take a backlash reading.

Pinion (14T) backlash	0.2 ~ 0.4 mm (0.008 ~ 0.016 in.)
-----------------------	-------------------------------------

3. If reading is outside of specified range, remove gear case and adjust shim between pinion (14T) on differential shaft and ball bearing. Shim stock for this adjustment is available in the following thicknesses:

Thickness	Part No.
Shim set	77-4020
0.1 mm (0.004 in.)	76-7520
0.2 mm (0.008 in.)	76-7530
0.4 mm (0.016 in.)	76-7540

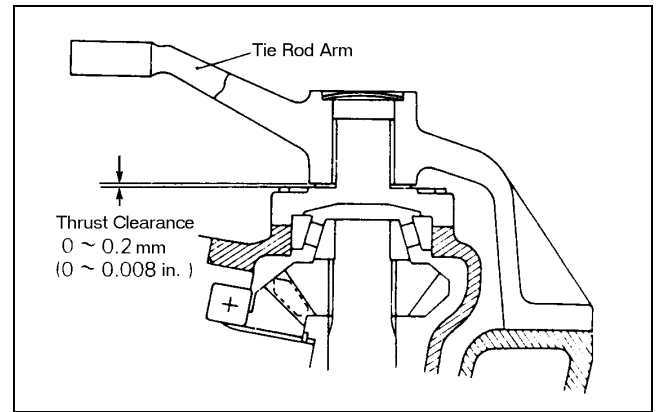


Figure 38

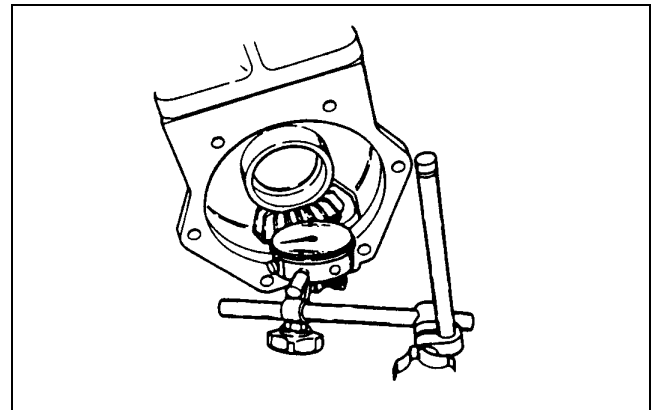


Figure 39

4. After obtaining proper pinion backlash, grease o-ring and fit it to mating face of axle housing. Secure gear case to housing by tightening bolts to the following torque value:

Torque specification	5.0 ~ 6.0 kg-m (36 ~ 43 ft-lb)
----------------------	-----------------------------------

### Reassembling Wheel Shaft

1. Grease oil seal and fit it to bearing holder.
2. Insert shaft into holder. Install ball bearing and retain bearing by installing circlip.
3. Mount bevel gear (29T) on splined end of shaft.
4. Fit bearing holder (complete with shaft and bevel gear) to final case and temporarily secure it bolting. Leave bolts lightly tightened.

NOTE: Inner ball bearing is left out at this time.

5. Check backlash between bevel gear (29T) and pinion (15T) by installing dial indicator on tip of wheel shaft. Adjust shim between bevel gear (29T) and ball bearing if reading is outside of specification:

Bevel gear (29T) backlash	0.2 ~ 0.4 mm (0.008 ~ 0.016 in.)
---------------------------	-------------------------------------

Shim stock for this adjustment is available in the following thicknesses:

Thickness	Part no.
Shim set	77-4030
0.1 mm (0.004 in.)	76-7890
0.2 mm (0.008 in.)	76-7900
0.4 mm (0.016 in.)	76-7910

6. After obtaining proper backlash, remove bearing holder. Apply Loctite 680 (or equivalent) to inner race bore of bearing. Press inner race of bearing onto wheel shaft and clean off excess Loctite. Install outer portion of bearing. Apply sealant to mating face of final case and attach holder. Tighten bolts to following torque value:

Torque specification	2.5 ~ 3.0 kg-m (18 ~ 22 ft-lb)
----------------------	-----------------------------------

7. Use a torque wrench as shown to check final case for torque required to turn it around gear case and make sure that no more than 0.03 kg-m (0.22 ft-lb) is required.

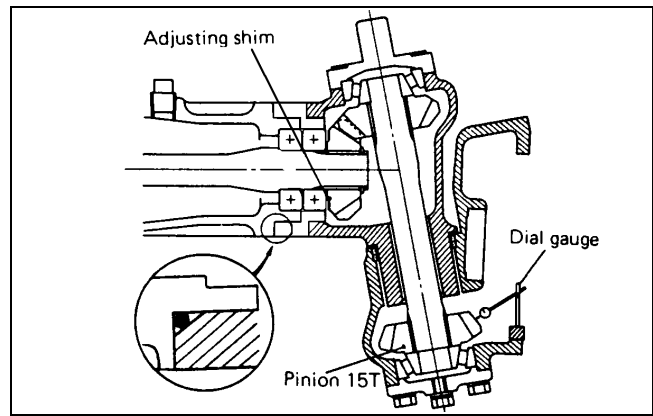


Figure 40

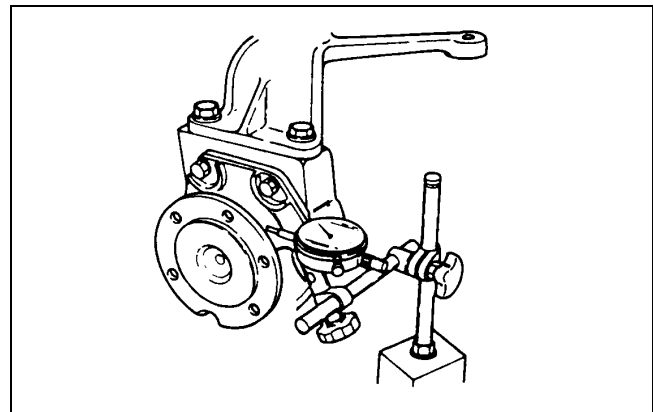


Figure 41

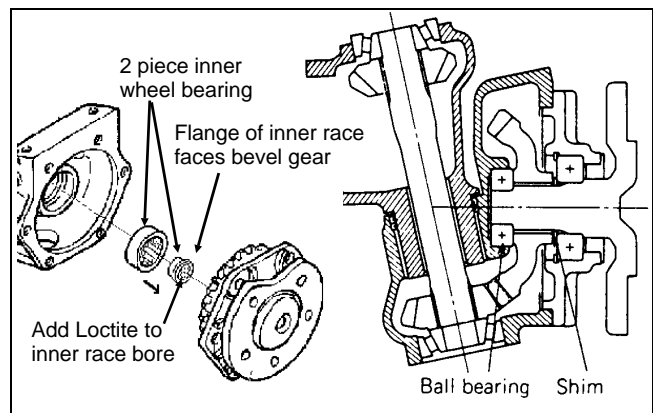


Figure 42

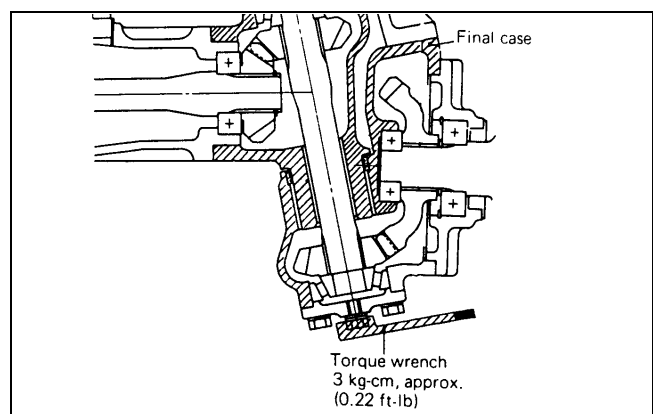


Figure 43

**Installing Axle on Machine**

- 1. Support axle under machine with a jack.
- 2. Install axle pivot pin to secure axle to frame. Make sure to install thrust washers between axle pivot and frame.
- 3. Install hydraulic motor to adaptor housing.
- 4. Install wheels to axle. Tighten wheel bolts to a torque of 85 - 100 ft-lb.
- 5. Fill axle with SAE 80-90W EP gear lube. Lubricant capacity is approximately 80 oz. (2.5 U.S. qt.).
- 6. Check rear wheel toe-in and adjust if necessary.

Rear wheel toe-in	0.25 in.
-------------------	----------





# PTO (Power Take-Off) System

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# Specifications

Item	Specification
PTO Clutch air gap	0.011 - 0.021 inches
Belt adjustment	180 ft-lb torque (20 inch long torque wrench in square hole of clutch plate)

## Special Tools

Order special tools from *TORO SPECIAL TOOLS AND APPLICATIONS GUIDE (Commercial Products)*.

Some tools may be listed in the Groundsmaster 455-D Parts Catalog. Tools may also be available from a local supplier.

---

### Bearing Locknut Wrench (TOR4050)

Use this tool (TOR4050) to remove and install the PTO drive pulley bearing locknut (Fig. 6, Item 1).

---

### Bearing Locknut Wrench (TOR4051)

Use this tool (TOR4051) to remove and install the PTO lower driven pulley bearing locknut (Fig. 10, Item 30).



# Adjustments

## PTO Belt Adjustment

1. Remove (2) screws securing PTO belt cover to adapter plate and (1) screw securing belt cover to tab on spring anchor. Remove cover.

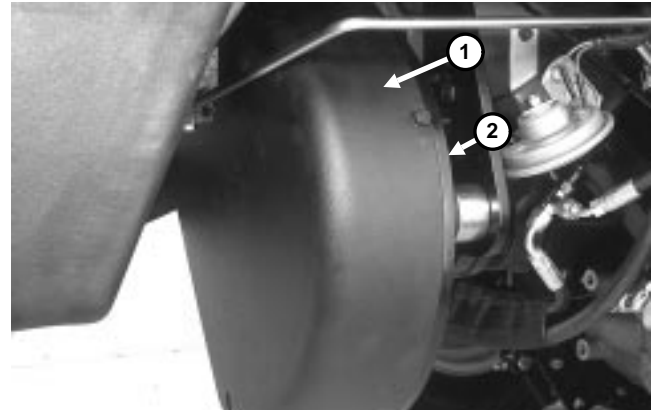


Figure 1

- 1. PTO belt cover
- 2. Adapter plate

2. Loosen (3) flange screws and flange nuts securing adapter plate to clutch plate.

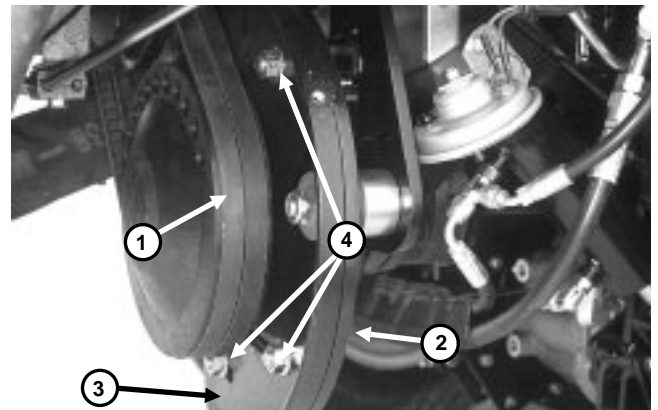


Figure 2

- 1. PTO belt
- 2. Adapter plate
- 3. Clutch plate
- 4. Flange nuts (3)

3. Insert end of 1/2" drive, 20" long, torque wrench into square hole in clutch plate. With wrench handle parallel to ground, pull wrench upward until 180 ft-lbs. of torque is applied to tension belt.

4. Tighten flange screws and flange nuts locking adjustment.

5. Install PTO belt cover.

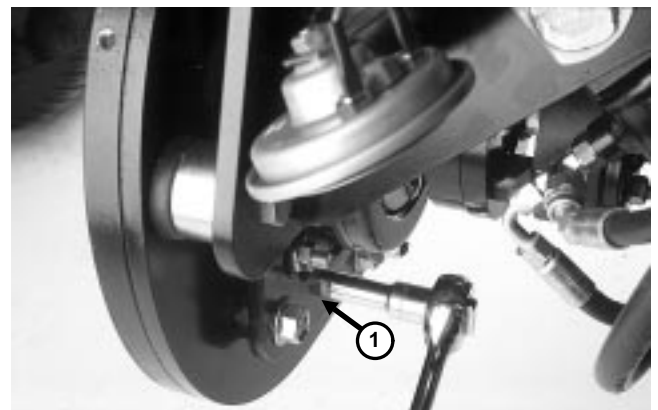


Figure 3

- 1. Square hole

---

## PTO Clutch Adjustment

1. To adjust clutch, tighten or loosen locknuts on flange studs.
2. Check adjustment by inserting feeler gauge through slots next to flange studs.
3. The proper disengaged clearance between the clutch plates is 0.011 - 0.021 inches. It will be necessary to check this clearance at each of the three slots to ensure the plates are parallel to each other.

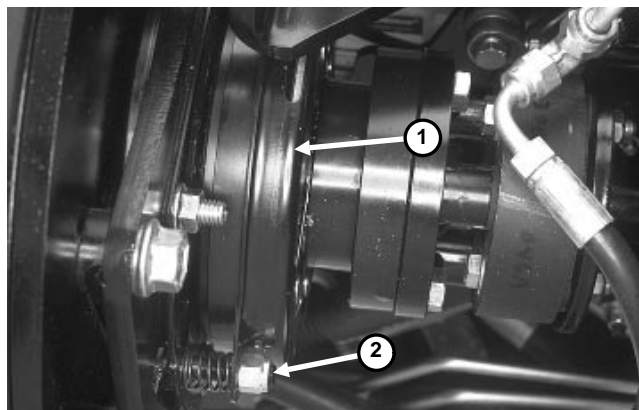


Figure 3

1. PTO clutch
2. Flange studs

# Repairs

## PTO Belt Replacement

1. Remove (2) screws securing PTO belt cover to adapter plate and (1) screw securing belt cover to tab on spring anchor. Remove cover.

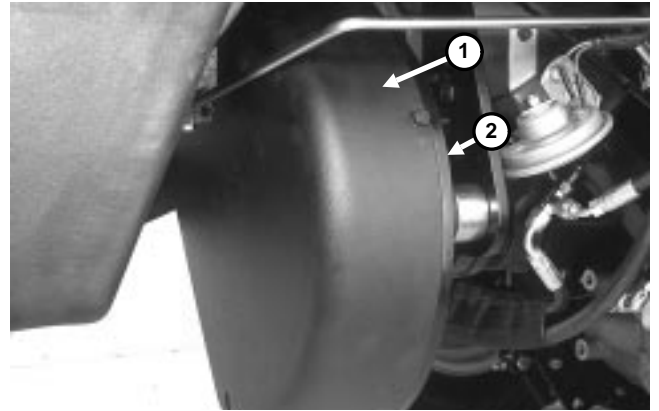


Figure 4

- 1. PTO belt cover
- 2. Adapter plate

2. Remove tension on belt by loosening three (3) flange screws and flange nuts securing adapter plate to clutch plate.

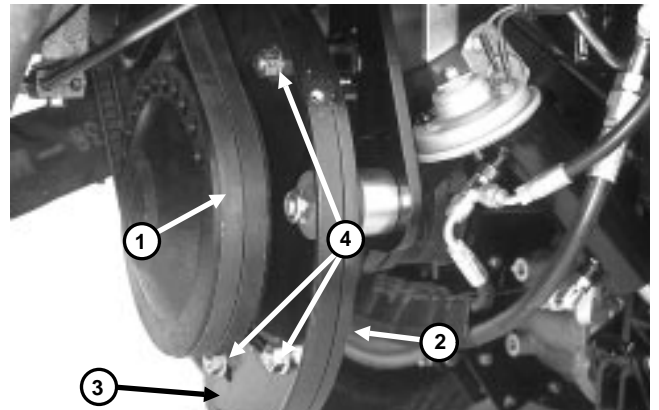


Figure 5

- 1. PTO belt
- 2. Adapter plate
- 3. Clutch plate
- 4. Flange nuts (3)

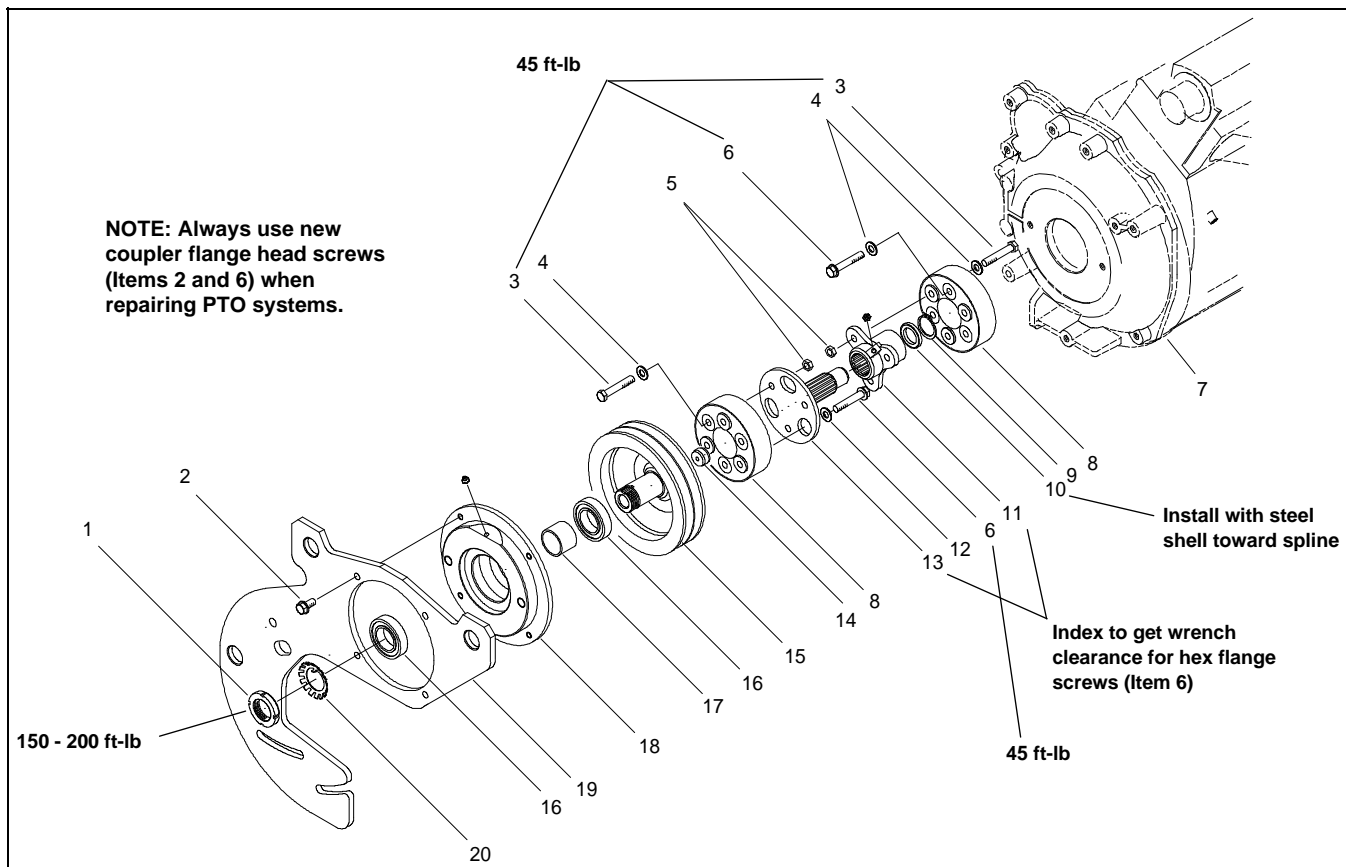


Figure 6

- 1. Bearing locknut
- 2. Hex flange head screw
- 3. Hex head capscrew
- 4. Flat washer
- 5. Locknut
- 6. Hex flange head screw
- 7. Engine

- 8. Rubber coupling
- 9. Retaining ring
- 10. Grease seal
- 11. Splined hub
- 12. Spacer
- 13. Driveshaft
- 14. Pulley plug

- 15. PTO pulley
- 16. Bearing
- 17. Bearing spacer
- 18. Bearing housing
- 19. Main adapter plate
- 20. Lock washer

3. Remove three (3) flange head screws (Fig. 6, Item 6) and spacers (Item 12) securing rubber coupling (Item 8) to PTO pulley (Item 15).

4. Push driveshaft into splined hub, as shown in Figure 7, so belts can be removed between rubber coupling and PTO pulley.

5. Remove belts.

6. Install new belts in pulley grooves, then connect driveshaft to rubber coupling. Make sure spacers (Item 12) are installed, then install new flange head screws and torque to 45 ft-lb.

7. Adjust PTO Belt (see PTO Belt Adjustment).

8. Install PTO belt cover.

**NOTE:** Check belt tension and adjust if necessary after first 25 hours of operation.

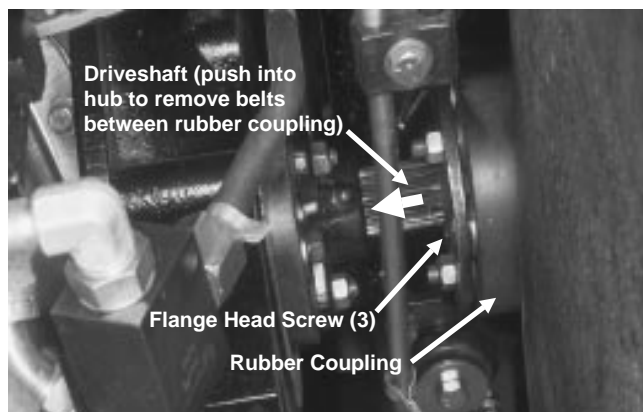


Figure 7

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## Engine Coupling Service

1. Remove three (3) flange head screws (Fig. 6, Item 6) securing driveshaft (Item 13) to rubber coupling (Item 8). Make sure you account for spacers (Item 12).
2. Remove three (3) flange head screws (Item 6) securing rubber coupling to engine. Be sure you account for flat washers (Item 4).
3. Push driveshaft into splined hub (Item 11) and remove coupling assembly.
4. Inspect rubber couplings, driveshaft and splined hub and replace as necessary.

5. Install grease seal (Item 10) so steel shell is towards spline. secure seal in place with retaining ring (Item 9).

NOTE: Seal (Item 10) is retained with Loctite on units with Serial Number 20001 - 29999.

6. When assembling parts, index driveshaft and splined hub to get clearance for hex flange screws that secure driveshaft to rubber coupling.
7. Install new fasteners (Item 6) and torque to 45 ft-lb.
8. Lubricate slip joint with No. 2 General Purpose Lithium Base Grease at grease fitting on coupling.

---

## PTO Drive Pulley and Bearing Service

NOTE: A special tool (TOR4050) is required remove and install the bearing locknut (Fig. 6, Item 1).

1. Remove engine coupling assembly (see Engine Coupling Service).
2. Disconnect hydraulic pump assembly from bearing housing (Item 18). NOTE: To prevent contamination of hydraulic system do not disconnect hydraulic lines from pump assembly.
3. Loosen belt tension and remove PTO belts (see PTO Belt Replacement).
4. Remove four (4) flange screws (Item 2) securing bearing housing (Item 18) to main adapter plate (Item 19), then remove bearing housing and PTO drive pulley assembly.
5. Remove bearing locknut (Item 1) and lockwasher (Item 20.)
6. Use a press to remove pulley (Item 15).
7. Use a suitable puller to remove bearings (Item 16). Remove bearing spacer (Item 17).
8. Inspect bearings and pulley. Replace parts if worn or damaged.
9. Use a press to install one bearing (Item 16) into bearing housing (Item 18). When installing bearing, press on OUTER race of bearing

10. Install bearing spacer (Item 17) and press other bearing (Item 16) into bearing housing until bearings contact the spacer. When installing bearing, press on OUTER race of bearing.

11. Make sure plug (Item 14) is installed in pulley (Item 15).

12. Use a press to push the bearing housing and bearings onto the pulley (Item 15). Press on INNER race of bearing.

13. Install lockwasher (Item 2) and bearing locknut (Item 1) to pulley shaft. Use special tool (TOR4050) and a torque wrench to tighten locknut. Tighten to a torque of 150 - 200 ft-lb.

14. Install bearing housing and pulley assembly to main adapter plate (Item 19) and secure with four (4) flange screws (Item 2).

15. Install belts on PTO drive pulley.

16. Apply Never-Seez or equivalent to spline of hydraulic pump shaft, then install hydraulic pump assembly.

17. Install engine coupling assembly (see Engine Coupling Service).

18. Add No. 2 General Purpose Lithium Base Grease at grease fitting on bearing housing (Fig. 6, Item 18).

## PTO Clutch Removal and Installation

**NOTE:** Always use new coupler flange head screws (Items 2 and 6) when repairing PTO systems.

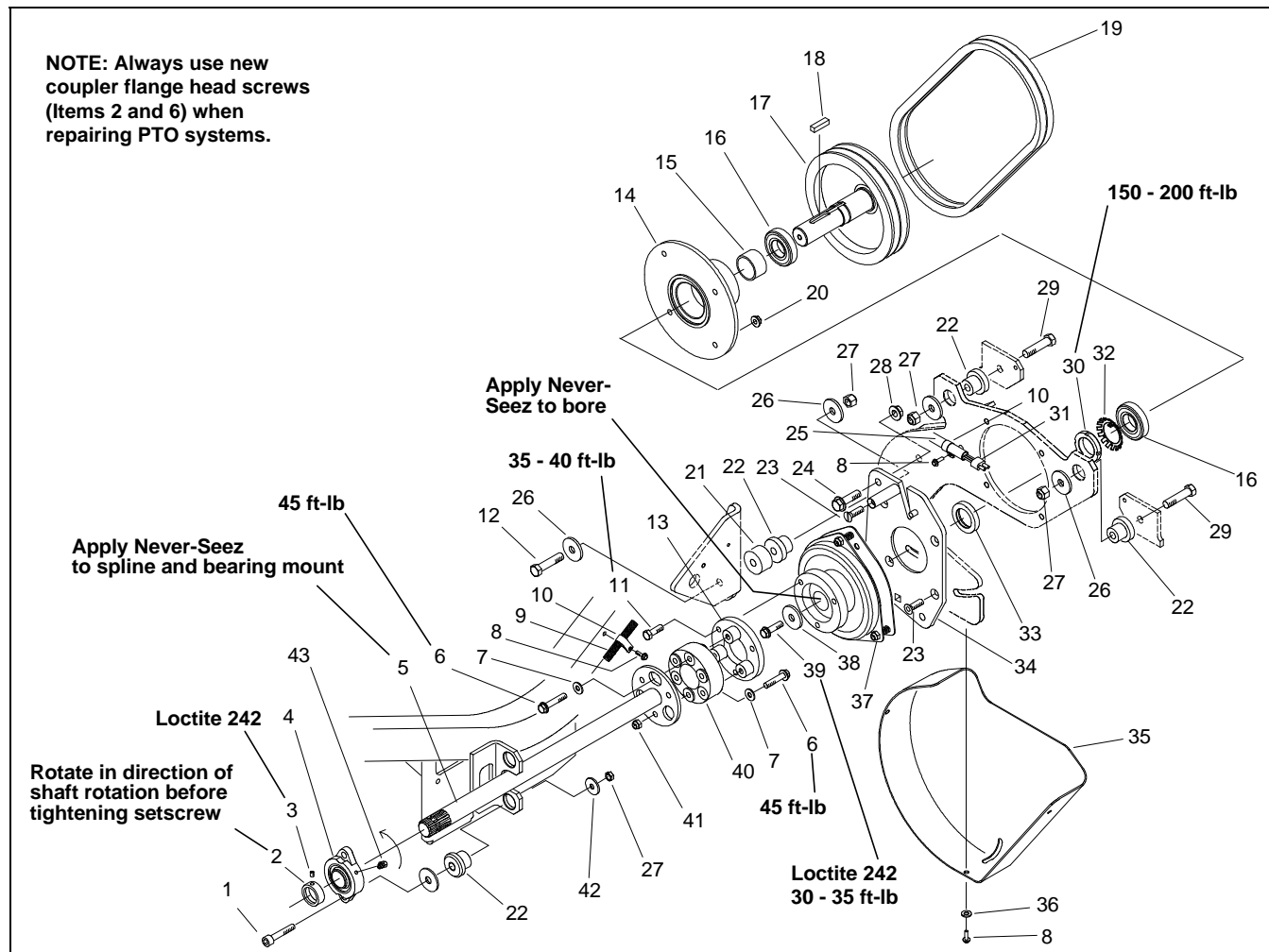


Figure 8

- |                           |                       |                       |
|---------------------------|-----------------------|-----------------------|
| 1. Socket head screw      | 16. Ball bearing      | 30. Bearing locknut   |
| 2. Bearing collar         | 17. Lower pulley      | 31. Main wire harness |
| 3. Set screw              | 18. Key               | 32. Lockwasher        |
| 4. Bearing                | 19. Belt set          | 33. Clutch spacer     |
| 5. PTO shaft              | 20. Locknut           | 34. Clutch plate      |
| 6. Flange head screw      | 21. Spacer            | 35. Belt cover        |
| 7. Flat washer            | 22. Rubber mount      | 36. Flat washer       |
| 8. Hex washer head screw  | 23. Special screw     | 37. Clutch            |
| 9. Wire harness           | 24. Flange head screw | 38. Washer            |
| 10. J-clamp               | 25. Wire cover        | 39. Flange head screw |
| 11. Hex head bolt         | 26. Thrust washer     | 40. Rubber flange     |
| 12. Screw                 | 27. Locknut           | 41. Locknut           |
| 13. Clutch adapter        | 28. Flange head nut   | 42. Washer            |
| 14. Lower bearing housing | 29. Hex head capscrew | 43. Grease fitting    |
| 15. Lower bearing spacer  |                       |                       |

1. Disconnect clutch electrical connector.
  2. Loosen PTO shaft bearing collar (Fig. 8, Item 2) to allow shaft movement.
  3. Remove three (3) bolts (Item 11) securing clutch adapter (Item 13) to clutch.
  4. Remove three (3) flange head screws (Item 6) and flat washers (Item 7) securing rubber flange (Item 40) to clutch adapter (Item 13).
  5. Remove clutch adapter (Item 13).
  6. Remove flange head screw (Item 39) and washer (Item 38) securing clutch assembly (Item 37) to shaft of lower pulley (Item 17).
  7. Remove the clutch assembly. Make sure you account for the key (Item 18) and clutch spacer (Item 33).
  8. Before installing clutch assembly, apply Never-Seez or equivalent to bore of clutch (Item 13). Install clutch spacer (Item 33) and install key (Item 18) in keyway on shaft of lower pulley (Item 17).
  9. Align key on lower pulley with keyway in clutch bore and install clutch assembly on lower pulley shaft. Make sure key engages both clutch sections.
- NOTE: Mark keyway location on end of shaft. Mark keyway slot on outer clutch bearing. Install clutch assembly on shaft by lining up the marks.
10. Make sure hole in clutch field rotor plate is aligned with pin on clutch plate. Apply Loctite 242 or equivalent to flange head screw (Item 39) then secure clutch in place with flange head screw and special washer (Item 38). Tighten flange head screw to a torque of 30 - 35 ft-lb.
  11. Connect clutch electrical connector. Adjust clutch air gap (see Clutch Adjustment in the Adjustments section of this chapter).
  12. Install PTO shaft to clutch and retighten bearing collar (Item 2).



Figure 9

## Lower Pulley and Bearing Service

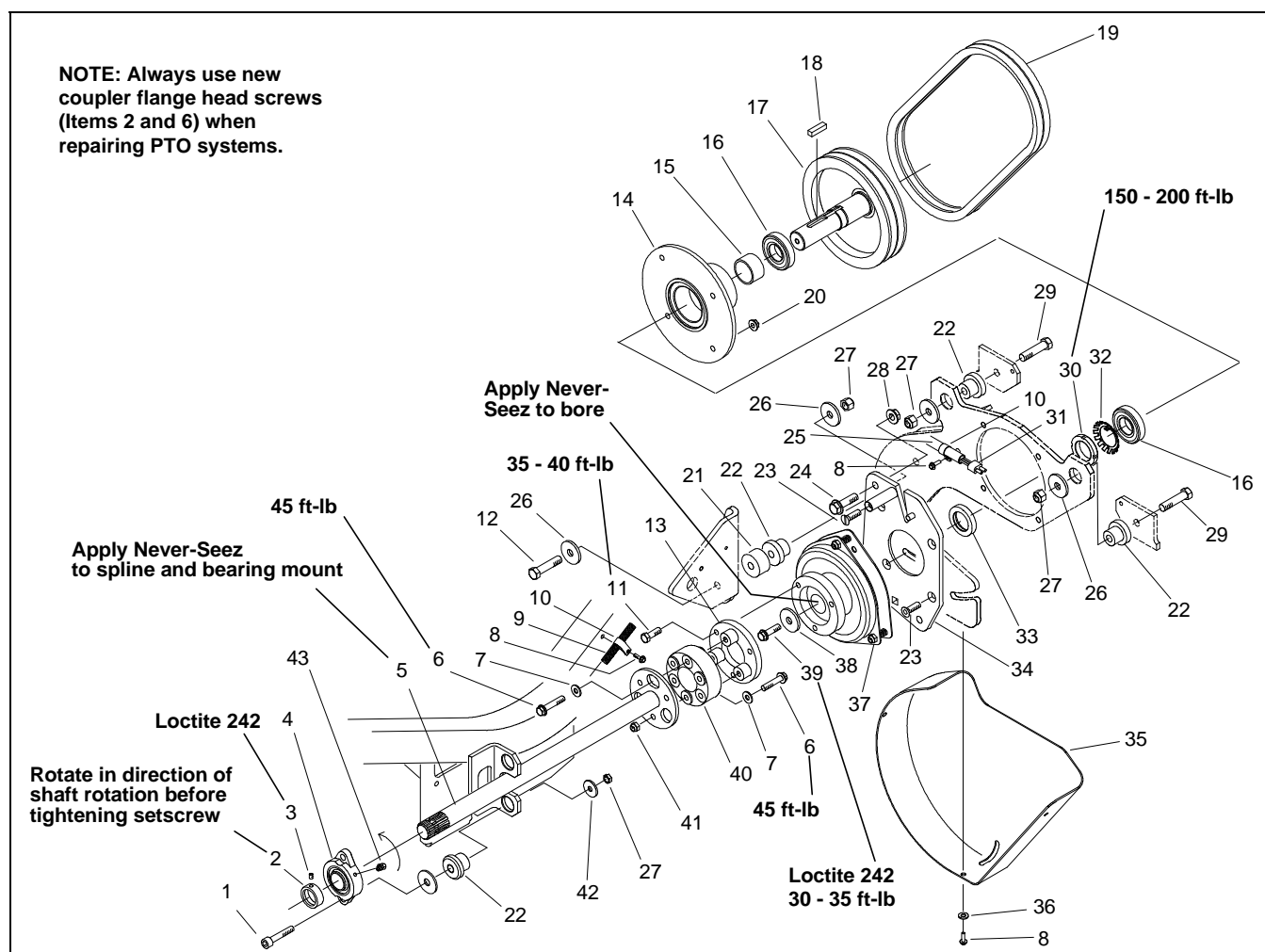


Figure 10

1. Socket head screw
2. Bearing collar
3. Set screw
4. Bearing
5. PTO shaft
6. Flange head screw
7. Flat washer
8. Hex washer head screw
9. Wire harness
10. J-clamp
11. Hex head bolt
12. Screw
13. Clutch adapter
14. Lower bearing housing
15. Lower bearing spacer

16. Ball bearing
17. Lower pulley
18. Key
19. Belt set
20. Locknut
21. Spacer
22. Rubber mount
23. Special screw
24. Flange head screw
25. Wire cover
26. Thrust washer
27. Locknut
28. Flange head nut
29. Hex head capscrew

30. Bearing locknut
31. Main wire harness
32. Lockwasher
33. Clutch spacer
34. Clutch plate
35. Belt cover
36. Flat washer
37. Clutch
38. Washer
39. Flange head screw
40. Rubber flange
41. Locknut
42. Washer
43. Grease fitting

**NOTE:** A special tool (TOR4051) is required remove and install the bearing locknut (Fig. 10, Item 30).

1. Remove PTO clutch (see PTO Clutch Removal and Installation).

2. Loosen belt tension and remove PTO belts (see PTO Belt Replacement).

3. Remove four (4) locknuts (Fig. 10, Item 20) and special screws (Item 23) securing lower bearing housing (Item 14) to clutch plate (Item 34).

4. Remove lower bearing housing and pulley assembly.

5. Remove bearing locknut (Item 30) and lockwasher (Item 32).



6. Use a press to remove pulley (Item 17).
7. Use a puller to remove bearings (Item 16). Remove bearing spacer (Item 15).
8. Inspect bearings and pulley. Replace parts if worn or damaged.
9. Use a press to install one bearing (Item 16) into lower bearing housing (Item 14). When installing bearing, press on OUTER race of bearing
10. Install lower bearing spacer (Item 15) and press other bearing (Item 16) into bearing housing until bearings contact the spacer. When installing bearing, press on OUTER race of bearing.
11. Use a press to push the lower bearing housing and bearings onto the lower pulley (Item 17). Press on INNER race of bearing.
12. Install lockwasher (Item 32) and bearing locknut (Item 30) to pulley shaft. Use special tool (TOR4051) and a torque wrench to tighten locknut. Tighten to a torque of 150 - 200 ft-lb.
13. Install lower bearing housing and pulley assembly to main clutch plate (Item 34) and secure with four (4) special screws (Item 23) and locknuts (Item 20).
14. Install belts on PTO drive pulley.
15. Install clutch.

---

## PTO Shaft and Bearing Service

1. Remove driveshaft between cutting unit and tractor.
2. Loosen setscrew (Fig. 10, Item 3) and turn bearing collar (Item 2) in opposite direction of shaft rotation to remove.
3. Remove socket head screws (Item 1) and locknuts (Item 27) securing bearing (Item 4) to rubber mounts (Item 22).
4. Remove bearing (Item 4).
5. To remove PTO shaft, remove three (3) flange head screws (Item 6) and flat washers (Item 7) securing rubber flange (Item 40) to clutch adapter (Item 13).
6. Remove PTO shaft (Item 5) with rubber flange (Item 40) attached.
7. Replace PTO shaft if bent or if splines are damaged.
8. Install rubber flange (Item 40) to PTO shaft with new flange head screws (Item 6) flat washers (Item 7) and locknuts (Item 41). Tighten fasteners to a torque of 45 ft-lb.
9. Install PTO shaft with rubber flange to clutch adapter (Item 13) with new flange head screws (Item 6) and washers (Item 7). Tighten screws to a torque of 45 ft-lb.
10. Inspect rubber mounts (Item 22) and replace if worn or damaged.
11. Install bearing (Item 4) so screws (Item 1) and locknuts (Item 27) are snug, but not tight.
12. Rotate PTO shaft by hand so self-aligning bearing can find proper alignment position. Tighten locknuts (Item 27).
13. Set bearing collar (Item 2) against bearing, then turn collar in direction of shaft rotation to lock. Apply Loctite 242 or equivalent to setscrew (Item 3) before installing.
14. Lubricate bearing (Item 4) with No. 2 General Purpose Lithium Base Grease.

## Driveshaft Removal and Installation

1. To prevent possible PTO engagement, disconnect wire harness connector.

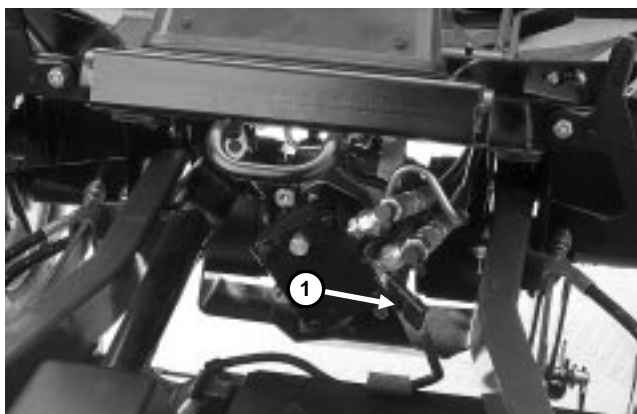


Figure 11

1. Wire harness connector

2. Remove socket head capscrews securing driveshaft yoke to gearbox input shaft.

3. Slide yoke off of gearbox input shaft.

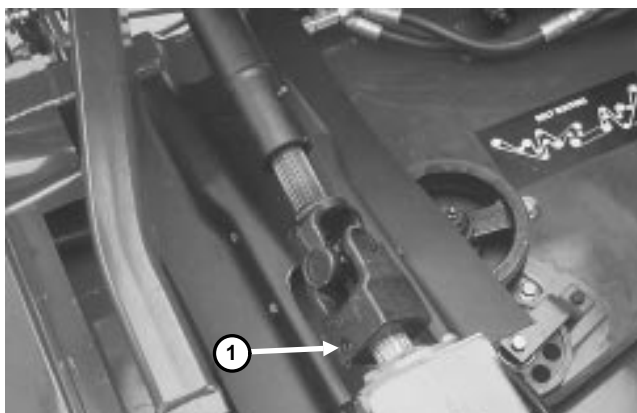


Figure 12

1. Socket head capscrew

4. Remove socket head capscrews securing driveshaft yoke to PTO shaft.

5. Slide yoke off of PTO shaft.



### **DANGER**

**DO NOT start the engine and engage the PTO switch when PTO shaft is not connected to gearbox on cutting unit. If engine is started and PTO shaft is allowed to rotate, serious injury could result.**

6. To install the driveshaft, apply Never-seez or equivalent to splines of gearbox input shaft and PTO shaft, then reverse steps 1 - 5 of above instructions. Tighten socket head capscrews at each end of driveshaft to a torque of 20 - 25 ft-lb.

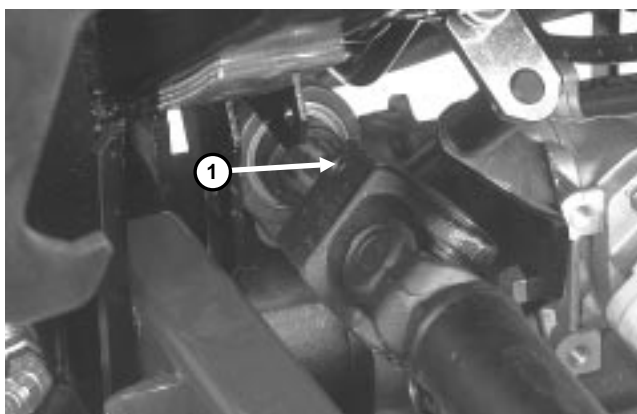


Figure 13

1. Socket head capscrew

## Driveshaft Universal Joint Replacement

1. Remove the driveshaft. (See Driveshaft Removal and Installation in this section of the book.)

2. Separate the two sections of the driveshaft.

3. Use a press or large vise to remove the cross and bearings by putting a small socket against one roller and a large socket against the yoke on the opposite side. As the vise is closed, the small socket will force the cross to push the opposite roller part way into the large socket.

4. When the roller is forced part way out, grasp the roller and strike the yoke to complete removal. DO NOT spill the needle bearings.

5. When replacing the U-joint, pack the roller bearings with multi-purpose grease. Pack carefully to eliminate trapped air. Install seals.

6. Start one of the rollers in the yoke. Insert from the bottom with the open side of the roller up to prevent loss of the needles. Make sure that each roller contains all of the needles.

7. Insert one of the cross trunnions into the roller. Start the other roller making certain it slips over the trunnion.

8. When partially seated, put the two rollers between the vise jaws. Squeeze until FLUSH with the yoke. Stop when flush; DO NOT OVER-TIGHTEN.

9. Tap on each roller until fully seated (use a brass drift or socket that is the full width of the roller).

10. Grease the fitting SLOWLY until it starts to show at the seals. Use a low pressure hand grease gun or a power gun equipped with a pressure relief valve. A high pressure grease gun can blow the rollers out of the yokes with the tremendous pressure; seals may also be damaged.

11. Test the action of the assembled joint. It should move throughout its range without binding. If a slight bind exists, hit the yoke lugs with a soft hammer. this will usually free the joint. If it does not, disassemble and check for the source of binding.

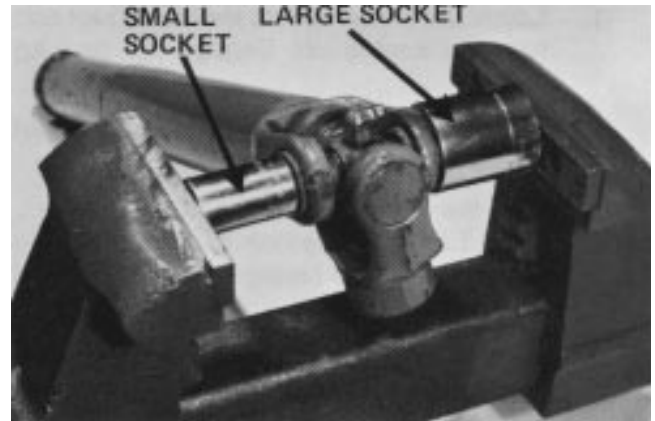


Figure 13



Figure 14

## PTO Clutch Service

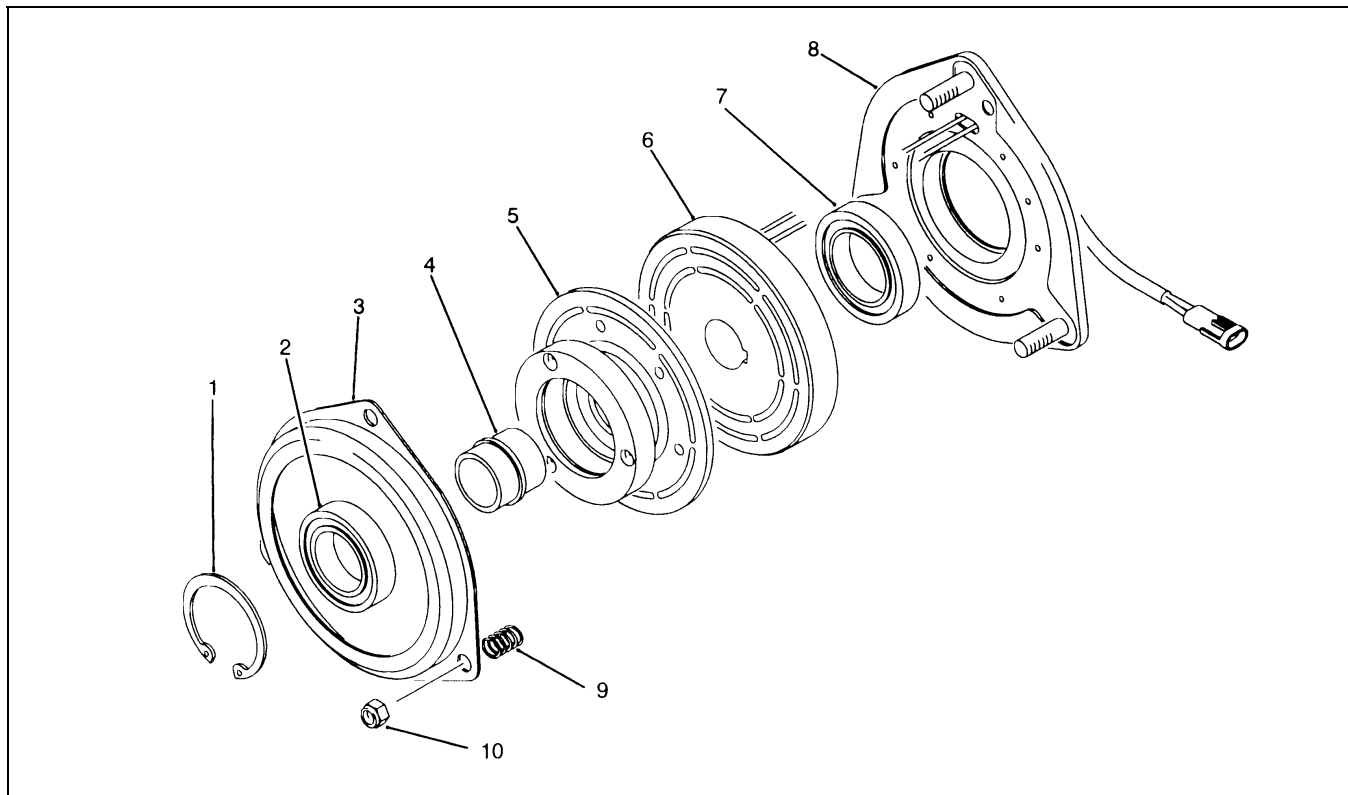


Figure 15

- 1. Retaining ring
- 2. Bearing
- 3. Brake plate
- 4. Bearing collar

- 5. Armature ass'y (Items 1, 2, 4, 5)
- 6. Field coil assembly
- 7. Field bearing

- 8. Field rotor ass'y (Items 6, 7, 8)
- 9. Spring
- 10. Locknut

NOTE: Individual parts (such as bearings) in the field rotor assembly or armature assembly are not serviceable and must be replaced as an assembly.

1. Remove the clutch assembly (see Clutch Removal and Installation in this section of the book).

2. Remove the three (3) lock nuts (Fig. 15, Item 10). Remove the brake plate (Item 3) and three (3) springs (Item 9).

3. Separate the armature assembly (Item 5) from the field rotor assembly (Item 8).

4. Reassemble the two clutch halves (armature assembly and field rotor assembly).

5. Install the three (3) springs (Item 9) over the studs. Install the brake plate (Item 3) and the three (3) locknuts (Item 10).



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# Specifications

Item	Specification
Cutting width	126" 54" center section 36" each wing 90" with one wing up
Height of cut range	1" - 5"
Height of cut adjustment	1/2" increments
Blade bolt torque	85 - 110 ft-lb
Spindle nut torque	150 - 170 ft-lb
Wing deck clutch air gap	0.016 ± 0.005"
Gearbox lubricant (Fig. 1)	SAE 80W90 API GL-5 gear lube

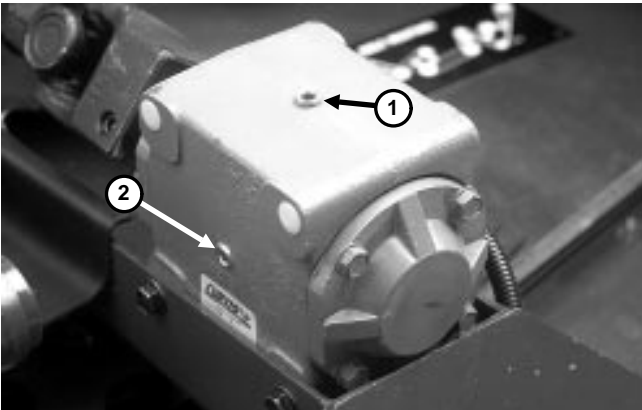


Figure 1

- 1. Filler plug
- 2. Check plug

# General Information

## Pivot (Tilt) Cutting Unit Upright

NOTE: Drive front wheels onto ramps before doing this procedure so there is room for cutting unit to pivot (tilt) upright.

1. Lower center and wing cutting units to the ground, then raise center cutting unit slightly, until rear deck straps hang freely on lift arm brackets. Stop engine after cutting unit is raised. Set parking brake.
2. Disconnect (3) hydraulic lines (quick couplers) and wire harness at rear of deck.
3. Remove hairpin cotters and H.O.C. pins securing rear deck straps to H.O.C. brackets on deck. Start engine and lower center deck to ground.
4. Remove socket head screws securing drive shaft yoke gear box input shaft. Slide yoke off shaft.



### CAUTION

**Do not start the engine and engage the PTO switch when PTO shaft is not connected to gear box on cutting unit. If engine is started and PTO shaft is allowed to rotate, serious injury could result.**

5. Sit on seat, start the engine and slowly raise the center cutting unit allowing cutting unit to pivot upright. Stop the engine and remove the key from the ignition switch.

## Pivot Cutting Unit Down into Operating Position

1. Sit on seat, start the engine and slowly lower the cutting units to the ground, then raise center cutting unit slightly, so rear deck straps can be mounted to lift arm brackets. Stop engine after cutting unit is raised. Set parking brake.
2. Line up holes in yoke and input shaft of gear box. Slide yoke onto shaft and secure together with socket head screws. Torque screws to 20 - 25 ft-lb.
3. Secure rear deck straps to H.O.C. brackets on deck with hair pin cotters and H.O.C. pins. Start engine and lower center cutting unit completely to floor. Make sure all lift levers are in the float position, then stop the engine.
4. Connect wire harness and (3) hydraulic lines couplers at rear of deck.

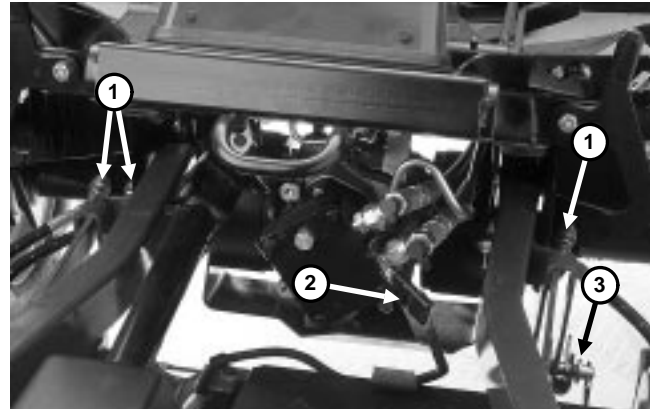


Figure 2

1. Hydraulic line couplers
2. Wire harness
3. Rear deck straps

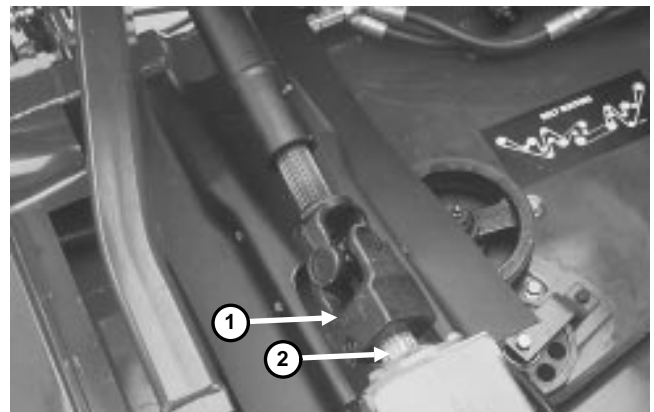


Figure 3

1. Drive shaft yoke
2. Gearbox input shaft

# Adjustments

## Height of Cut Adjustment

The height of cut is adjustable from 1 to 5 inches in 1/2 inch increments. Positioning the castor wheel axles in the top holes of the castor forks or pivots (see Chart below) allows low range height of cut settings from 1 to 3-1/2 inches. Positioning the castor wheel axles in the lower holes of the front castor forks or rear castor pivots allows (see Chart below) high range height of cut settings from 2-1/2 to 5 inches.

1. Start the engine and raise the cutting unit so height of cut can be changed. Stop engine after cutting unit is in raised position.
2. Position all castor wheel axles in the same holes in the castor forks or pivots.

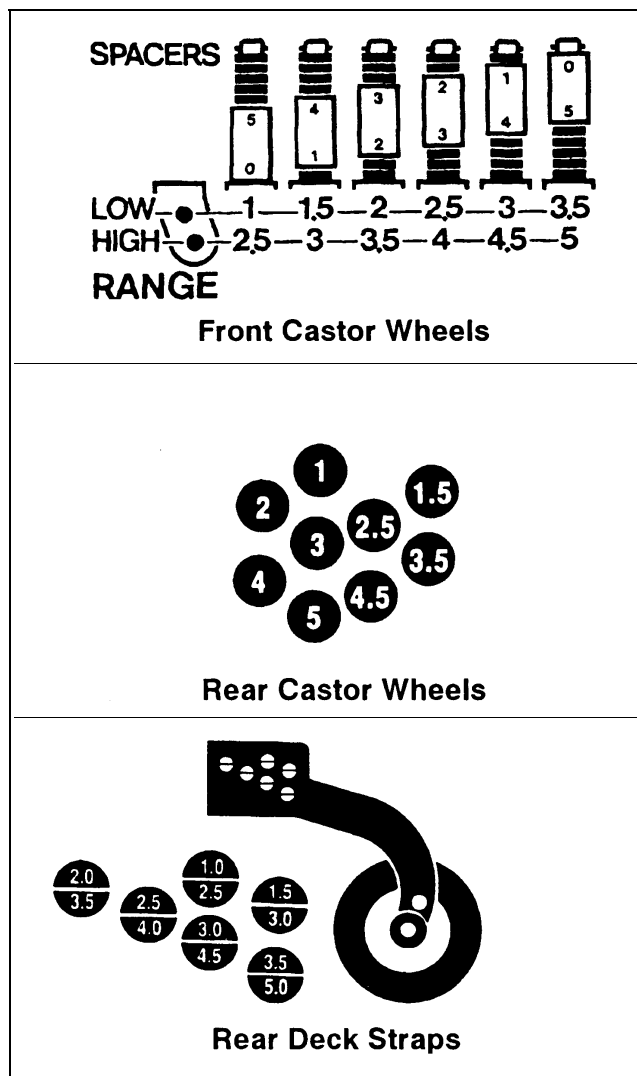


Figure 4



### Front Castor Wheels

1. Remove lynch pin from spindle shaft and slide spindle out of front castor arm. Slide spacers onto spindle shaft to get desired height of cut.
2. Push castor spindle through front castor arm install remaining spacers onto spindle and install lynch pin to secure assembly.

NOTE: Make sure washer remains on bottom of spindle shaft.

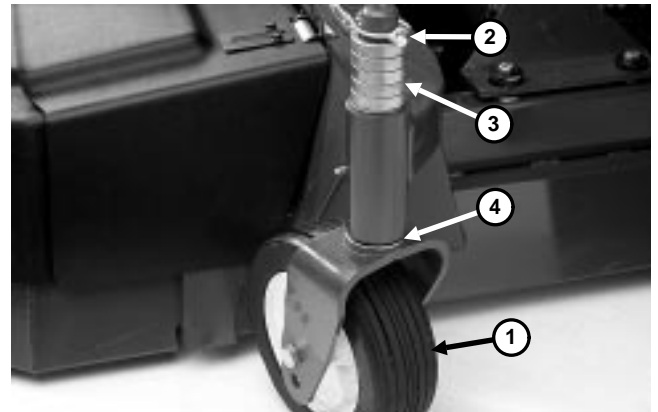


Figure 5

1. Front castor wheel
2. Lynch pin
3. Spacers
4. Washer

### Rear Castor Wheels

1. Remove hairpin cotter and H.O.C. pin securing rear castor pivot arm to deck bracket.
2. Align the pivot arm holes with selected height of cut bracket holes in the deck frame, install H.O.C. pin and secure with hairpin cotter.

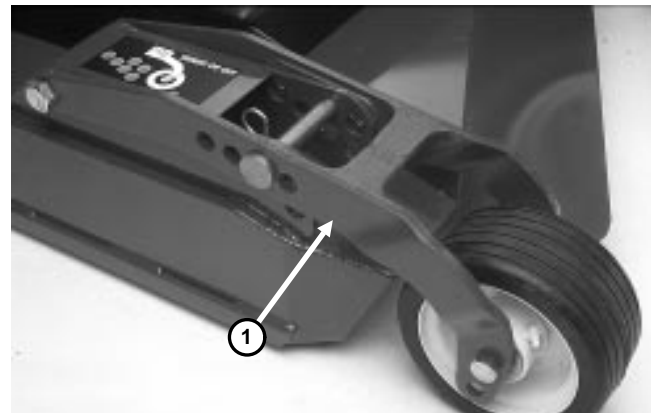


Figure 6

1. Rear castor pivot

### Rear Deck Straps

1. Lower center and wing cutting units to the ground, then raise center cutting unit slightly, until rear deck straps hang freely on lift arm brackets. Stop engine after cutting unit is raised.
2. Remove hairpin cotter and H.O.C. pin securing rear deck strap to H.O.C. bracket on deck.
3. Slide deck strap forward or backward until holes in strap are aligned with selected height of cut bracket holes in the deck frame, install H.O.C. pin and secure with hairpin cotter.

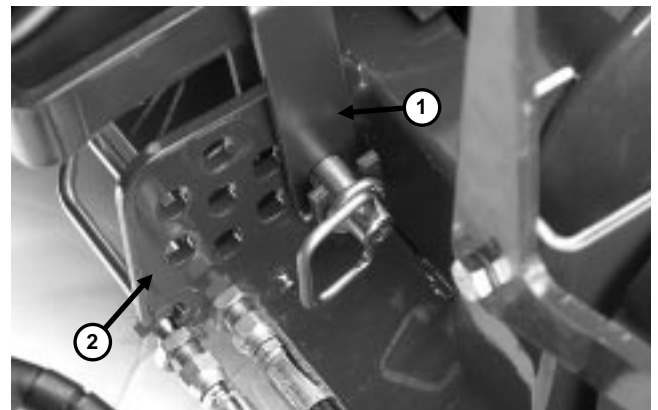


Figure 7

1. Rear deck straps
2. Lift arm brackets

## Safety Door Adjustment

On each side of the center deck is a safety door that opens and closes as the wing decks are lowered and raised. The doors open to provide overlap of the cutting blades when the wing units are down. The doors close to provide safety and protection when the wing units are raised. Check to make sure the forward, lower edge of door is even or 1/4" higher than lower edge of door guide when wing decks are in the fully raised, transport position. If an adjustment to the door is required, proceed as follows:

1. Loosen jam nuts securing ball joints to threaded rod.
2. Rotate threaded rod to raise or lower edge of door until it is even or 1/4" higher than lower edge of door guide when wing decks are in the fully raised, transport position.
3. Tighten jam nuts to lock adjustment.



### CAUTION

Check for proper operation of the safety doors each time the deck is cleaned and repair as needed.

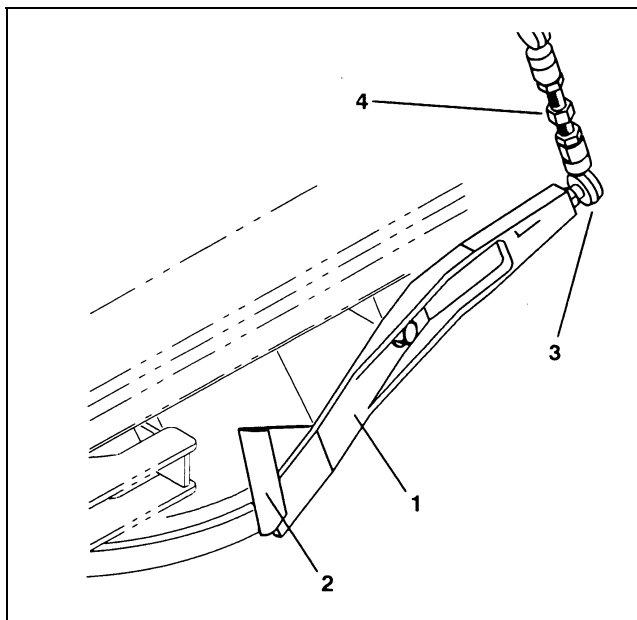


Figure 8

1. Safety door
2. Door guide
3. Ball joint
4. Threaded rod

## Blade Adjustment

To assure proper operation of the cutting unit, there must be  $0.25 \pm 0.12$ " clearance between the tips of the wing and center cutting unit blades.

1. Raise cutting unit so blades are visible and block center deck section so it cannot fall accidentally. Wing decks must be horizontal to center cutting unit.
2. Rotate a center and adjoining wing blade so there blade tips are aligned. Measure distance between blade tips, distance should be approximately  $0.25 \pm 0.12$ ".
3. To adjust distance, locate adjuster bolt on rear outside corner of center cutting unit. Loosen jam nut on adjuster bolt. Loosen or tighten adjuster bolts until  $0.25 \pm 0.12$ " clearance is attained, then tighten jam nut.
4. Repeat procedure on opposite side of cutting deck.

**IMPORTANT: Blade plane is adjusted at the factory and should not need further adjustment.**

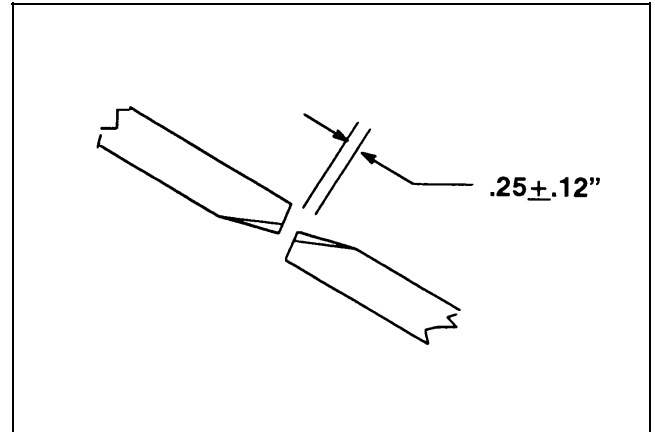


Figure 9

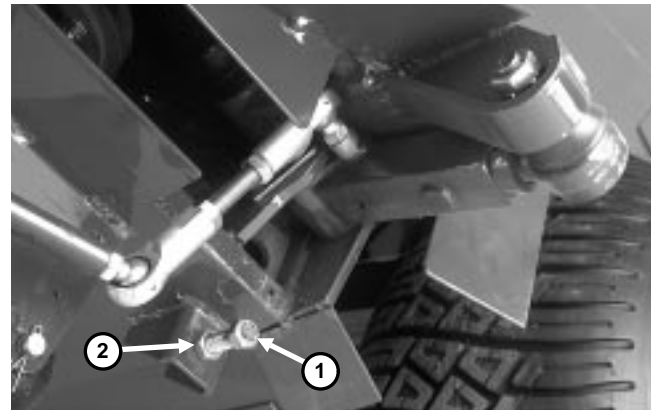


Figure 10

- 1. Adjuster bolt
- 2. Jam nut

---

## Belt Tension Adjustment

Each cutting unit drive belt is individually tensioned by a self tensioning spring loaded idler. When the idlers are properly adjusted, the black plastic sleeve should be flush (even) with the edge of the idler support. When 1/2" of the plastic sleeve is exposed, an adjustment is required. To assure proper operation of the cutting unit, check adjustment of spring loaded idler after first 10 hours of operation and every time maintenance on the belt is required.

1. Lower cutting unit to the shop floor. Remove belt covers from center and wing cutting units.
2. Measure the length of the exposed black plastic sleeve. If distance is 0 to 1/2", spring loaded idler is properly adjusted and belt tension is correct. If dimension is not correct, proceed to next step.
3. Loosen (2) flange head nuts securing idler adjuster tube to top of cutting deck.
4. Loosen jam nut on adjusting screw and rotate screw until the black plastic sleeve is flush (even) with the edge of idler support.
5. When distance is attained, tighten jam nut on adjusting screw and (2) flange head nuts securing idler adjuster tube to top of cutting deck.
6. Check adjustment on other adjusters and repeat procedure if required.

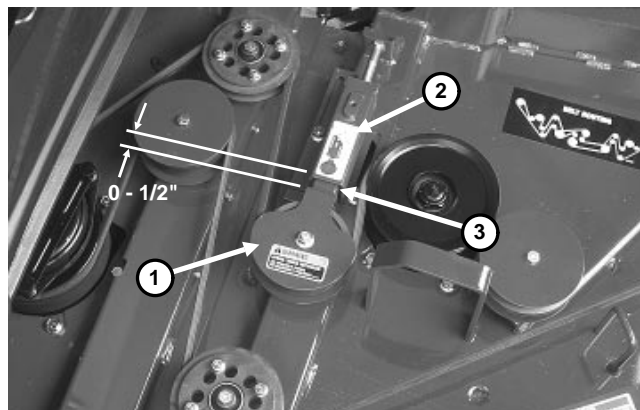


Figure 11

1. Spring loaded idler
2. Idler support
3. Black plastic sleeve

---

## Wing Deck Clutch Adjustment

The deck clutches are adjustable to ensure proper engagement and blade braking.

1. To adjust clutch, tighten or loosen locknuts on flange studs.
2. Check adjustment by inserting feeler gauge through slots next to flange studs.
3. The proper disengaged clearance between the clutch plates is 0.011 - 0.021 inches. It will be necessary to check this clearance at each of the three slots to ensure the plates are parallel to each other.

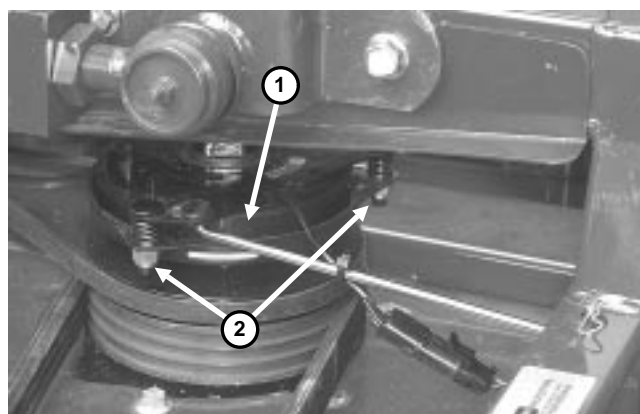


Figure 12

1. Clutch
2. Flange studs

# Repairs

## Separating Cutting Unit From Traction Unit

1. Lower center and wing cutting units to the ground: then raise center cutting unit slightly, until rear deck straps hang freely on lift arm brackets. Stop engine after cutting unit is raised. Set parking brake.

2. Remove hairpin cotters and H.O.C. pins securing rear deck straps to H.O.C. brackets on deck. Start engine and lower center cutting unit completely to floor. Make sure all lift levers are in float position, then stop the engine.

3. Disconnect (3) hydraulic lines (quick couplers) and wire harness at rear of deck.

4. Remove socket head screws securing drive shaft yoke gear box input shaft. Slide yoke off shaft.



### CAUTION

**Do not start the engine and engage the PTO switch when PTO shaft is not connected to gear box on cutting unit. If engine is started and PTO shaft is allowed to rotate, serious injury could result.**

5. Remove (4) capscrews, flat washers and flange nuts securing ball joint mounts to castor arms on cutting unit.

6. Roll the cutting unit away from the traction unit.

### Alternate Method

1. Lower center and wing cutting units to the ground, set parking brake and stop engine.

2. Disconnect (3) hydraulic lines (quick couplers) and wire harness at rear of deck.

3. Remove socket head screws securing drive shaft yoke gear box input shaft. Slide yoke off shaft.

4. Remove two (2) capscrews and locknuts securing cutting unit carrier frames to traction unit lift arms.

5. Slowly back traction unit away from cutting unit.

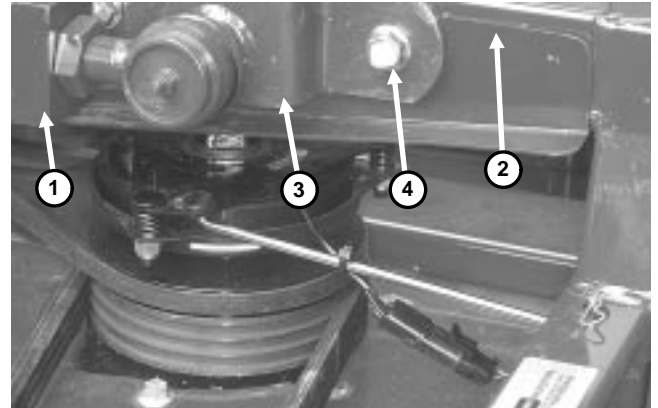


Figure 13

1. Push arm  
2. Castor arm

3. Ball joint mount  
4. Capscrews & washers

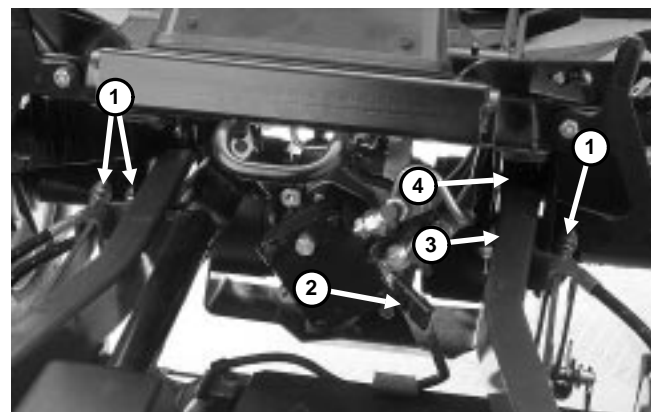


Figure 14

1. Hydraulic lines (quick couplers)  
2. Wire harness connector  
3. Cutting unit carrier frame  
4. Traction unit lift arm

## Mounting Cutting Unit to Traction Unit

1. With cutting unit on a level surface, move traction unit into position, aligning drive shaft yoke with gear box input shaft and lift arm ball joints with mounting holes in castor arms. Shut engine off.

2. Secure ball joint mounts to castor arms with cap-screws, flat washers and flange nuts. Flat washers to be positioned to outside of castor arm. Tighten cap-screws and flange nuts to a torque of 80 - 90 ft-lb.

3. Line up holes in yoke and input shaft of gear box. Slide yoke onto shaft and secure together with socket head screws. Torque screws to 20 - 25 ft-lb.

4. Start engine, raise center cutting unit slightly, so rear deck straps can be mounted on lift arm brackets. Stop engine after cutting unit is raised.

5. Secure rear deck straps to H.O.C. brackets on deck with hair pin cotters and H.O.C. pins. Start the engine and lower center cutting unit completely to floor. Make sure all lift levers are in the float position, then stop the engine.

6. Connect wire harness and (3) hydraulic lines couplers at rear of deck.

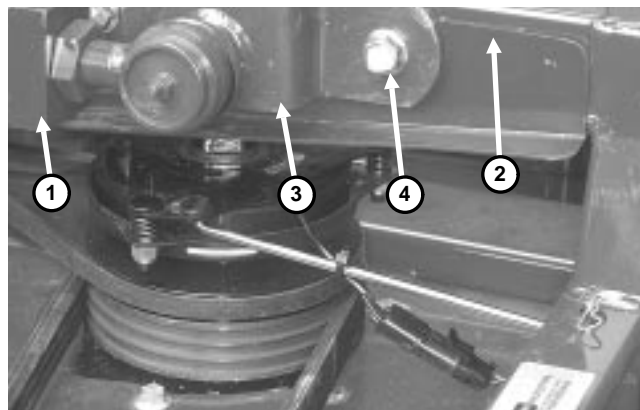


Figure 15

1. Push arm  
2. Castor arm

3. Ball joint mount  
4. Capscrews & washers

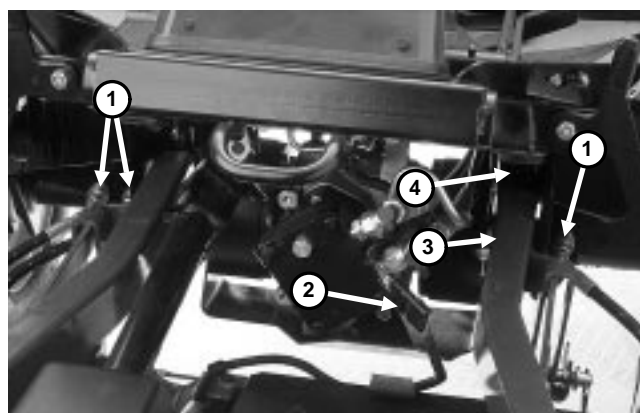


Figure 16

1. Hydraulic lines (quick couplers)  
2. Wire harness connector  
3. Cutting unit carrier frame  
4. Traction unit lift arm

## Drive Belt Replacement

Signs of a worn belt are: squealing when belt is rotating, blades slipping when cutting grass, frayed edges, burn marks and cracks. Replace a belt if any of these conditions are evident.

**IMPORTANT:** When installing new belts, do not force over pulleys or kink belt in place. This could fracture cords in belt, resulting in reduced belt life.

**NOTE:** Check tension of new belts after first 25 hours of operation.

1. Lower cutting unit to the shop floor. Remove belt covers from center and wing cutting units.

### To Remove Wing Deck Belts

2. To relieve tension on wing belt, pull back on idler pulley until holes in idler adjuster tube and tube sleeve are aligned. Thread a 5/16-18 capscrew into holes retaining parts.

3. Remove hairpin cotter securing clutch rod to front of cutting deck and disconnect rod from deck. Unplug clutch wire from harness.

4. To ease right wing belt removal, loosen or remove stationary idler pulley next to right wing's inner spindle pulley.

5. To relieve tension on center deck belt, pull back on idler pulley until holes in idler adjuster tube and tube sleeve are aligned. Thread a 5/16-18 capscrew into holes retaining parts.

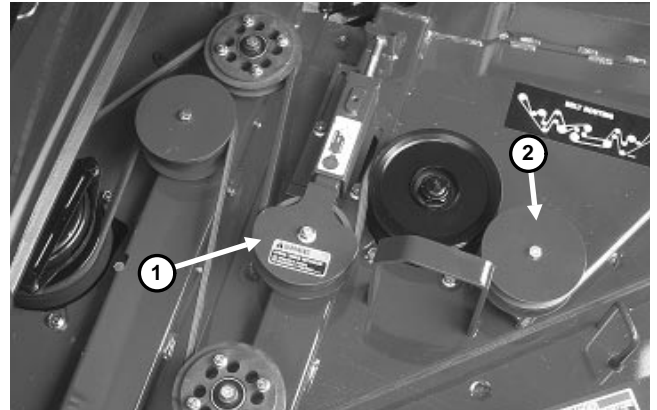


Figure 17  
(Left wing shown)

- 1. Spring loaded idler pulley
- 2. Stationary idler pulley

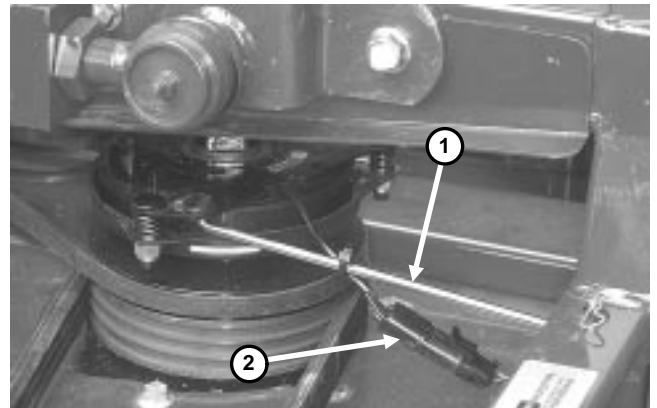


Figure 18

- 1. Clutch rod
- 2. Clutch wire

## To Remove Center Deck Belt

6. Wing deck belts must be removed before center deck belt can be removed, repeat steps 1 - 3 on previous page.

7. Remove (2) flange head screws securing drive shaft cover to gear box support and remove cover.

8. Remove capscrews and nuts securing front of gear box support to deck channels and loosen capscrews securing rear of gear box support to deck channels.

9. Raise front of gearbox support and remove old belt from around gear box pulley and remaining pulleys.

10. Route new belts around appropriate pulleys as shown.

**IMPORTANT: When installing new belts, do not force over pulleys or kink belt in place. This could fracture cords in belt, resulting in reduced belt life.**

11. Remount gear box support to deck channels with capscrews and nuts previously removed.

12. Reinstall drive shaft cover to gear box support with (2) flange head screws previously removed.

13. Remount clutch rod to deck with hairpin cotter and plug clutch connector into harness.

14. While holding idler pulley adjuster in position, carefully remove capscrew securing idler adjust or tube to tube sleeve. Allow idler pulley to release, tensioning belt.

15. Check idler pulley adjustment (see Belt Tension Adjustment).

16. Reinstall belt covers.

NOTE: Check tension of new belts after first 25 hours of operation.

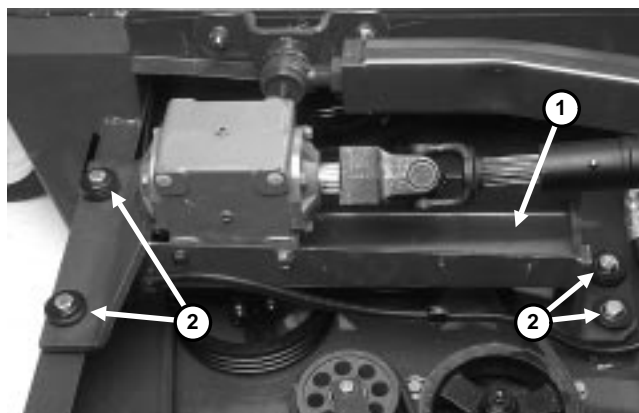


Figure 19

- 1. Gearbox support
- 2. Capscrews & nuts

## Belt Routing

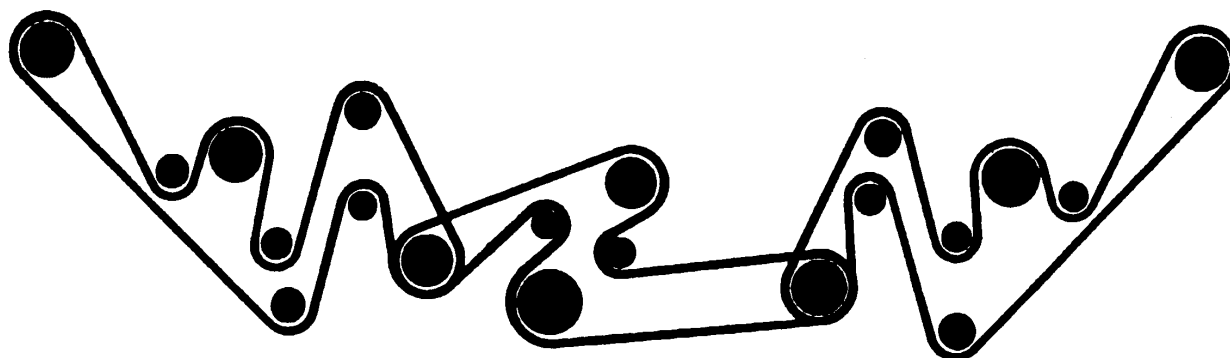


Figure 20



## Front Castor Arm Bushing Service

To check the bushings, move castor fork back and forth and from side to side. If castor spindle is loose inside the bushings, bushings are worn and must be replaced.

1. Raise cutting unit so wheels are off floor and block it so it cannot fall accidentally.
2. Remove lynch pin and spacer(s) from top of castor spindle.
3. Pull castor spindle out of mounting tube. Allow spacer(s) to remain on bottom of spindle.
4. Insert pin punch into top or bottom of mounting tube and drive bushing out of tube. Also drive other bushing out of tube. Clean inside of tubes to remove dirt.
5. Apply grease to inside and outside of new bushings. Using a hammer and flat plate, drive bushings into mounting tube.
6. Inspect castor spindle for wear and replace it if damaged.
7. Push castor spindle through bushings and mounting tube. Slide spacer(s) onto spindle. Install lynch pin on castor spindle to retain all parts in place.

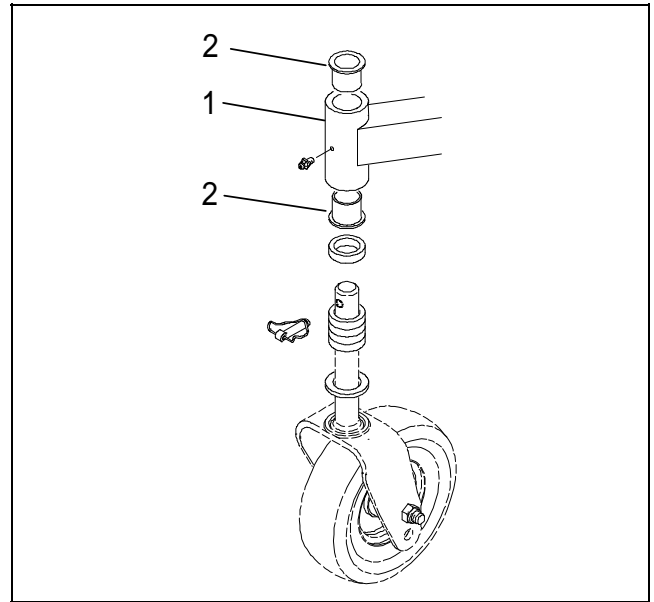


Figure 21

1. Bushing
2. Front castor arm tube

## Castor Wheel and Bearing Service

A wobbly castor wheel usually indicates a worn bearing.

1. Remove locknut from capscrew holding castor wheel assembly between front castor fork or rear castor pivot arm. Grasp castor wheel and slide capscrew out of fork or pivot arm.
2. Remove bearing from wheel hub and allow bearing spacer to fall out. Remove bearing from opposite side of wheel hub.
3. Check the bearings, spacer and inside of wheel hub for wear. Replace defective parts.
4. To assemble the castor wheel, push bearing into wheel hub. Slide bearing spacer into wheel hub. Push other bearing into open end of wheel hub to captivate the bearing spacer inside the wheel hub.
5. Install castor wheel assembly between castor fork and secure in place with capscrew and locknut.
6. Lubricate castor wheel bearing through grease fitting, using No. 2 general purpose lithium base grease.

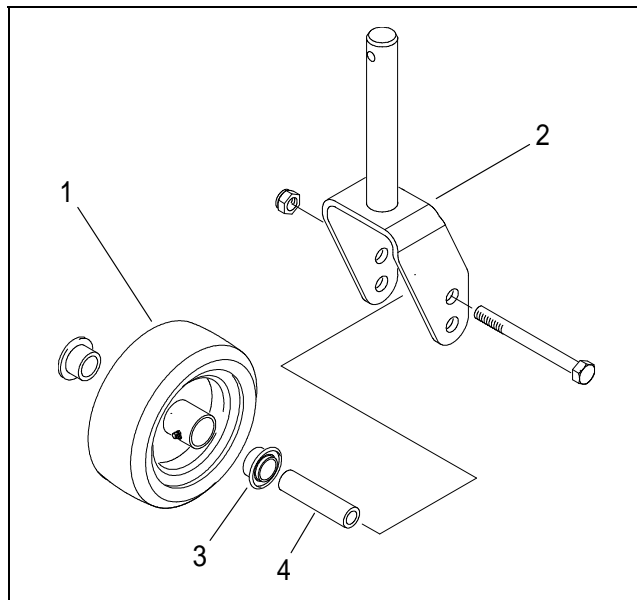


Figure 22

- |                      |                   |
|----------------------|-------------------|
| 1. Castor wheel      | 3. Bearing (2)    |
| 2. Front castor fork | 4. Bearing spacer |

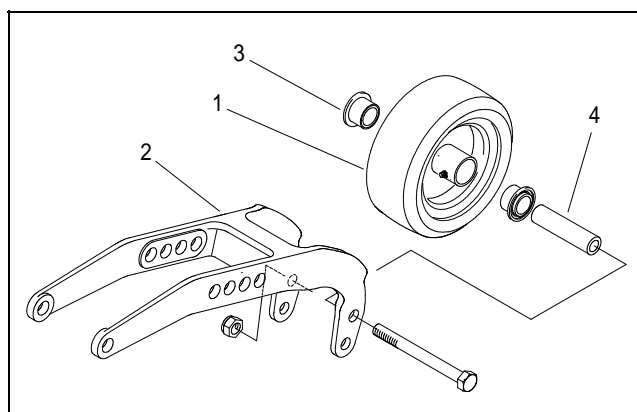


Figure 22

- |                          |                   |
|--------------------------|-------------------|
| 1. Castor wheel          | 3. Bearing (2)    |
| 2. Rear castor pivot arm | 4. Bearing spacer |

## Blade Removal and Installation

The blade must be replaced if a solid object is hit, the blade is out of balance or if the blade is bent. Always use genuine TORO replacement blades to be sure of safety and optimum performance. Never use replacement blades made by other manufacturers because they could be dangerous.



### CAUTION

**Do not try to straighten a blade that is bent, and never weld a broken or cracked blade. Always use a new blade to assure continued safety certification of the product.**

1. Raise cutting unit to highest position, shut the engine off and engage the parking brake. Engage locking latches to prevent cutting unit from falling accidentally.
2. Grasp end of blade using a rag or thickly padded glove. Remove blade bolt, washer (if equipped) anti-scalp cup and blade from spindle shaft.

NOTE: Units with S/N below 30001 will have a hex bolt and flat washer securing the blade. Units with S/N 30001 & up will have a hex flange bolt securing the blade.

3. Install blade sail facing toward cutting unit with anti-scalp cup, lockwasher and blade bolt. Tighten blade bolt to 85 - 110 ft-lb.

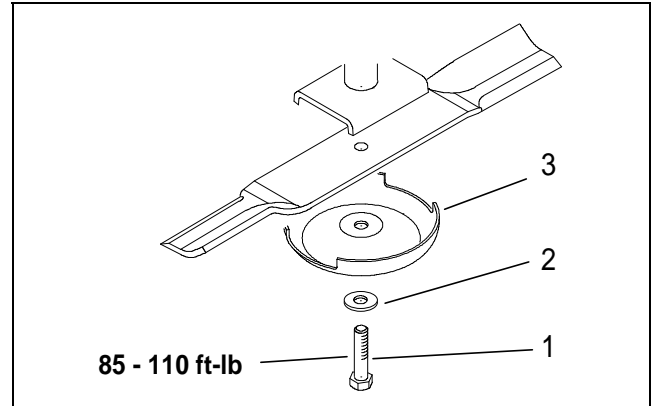


Figure 23

1. Blade bolt
2. Flat washer (S/N below 30001)
3. Anti-scalp cup

## Inspecting and Sharpening Blade

1. Raise cuffing unit to highest position, shut the engine off and engage the parking brake. Engage locking latches to prevent cutting unit from falling accidentally.

2. Examine cutting ends of the blade carefully, especially where the flat and curved parts of the blade meet. Since sand and abrasive material can wear away the metal that connects the flat and curved parts of the blade, check the blade before using the machine. If wear is noticed, replace the blade (see Cutting Blade Removal and Installation).

3. Inspect cutting edges of all blades. Sharpen the cutting edges if they are dull or nicked. Sharpen only the top of the cutting edge and maintain the original cutting angle to make sure of sharpness. The blade will remain balanced if same amount of metal is removed from both cutting edges.

4. To check blade for being straight and parallel, lay blade on a level surface and check its ends. Ends of blade must be slightly lower than the center, and cutting edge must be lower than the heel of the blade. This blade will produce good quality of cut and require minimal power from the engine. By contrast a blade that is higher at the ends than the center, or if cutting edge is higher than the heel, the blade is bent or warped and must be replaced.

5. Install blade sail facing toward cutting unit with anti-scalp cup, lockwasher and blade bolt. Tighten blade bolt to 85 - 110 ft-lb.

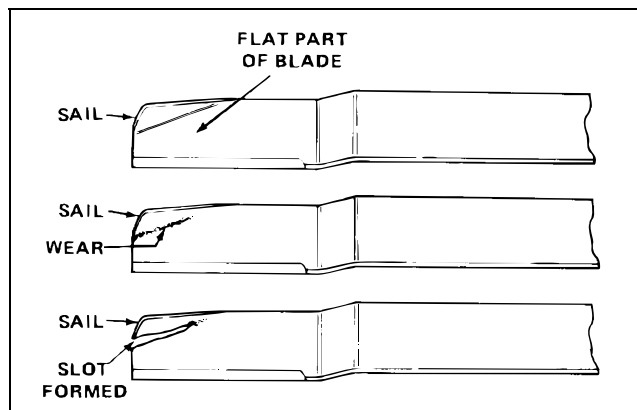


Figure 24

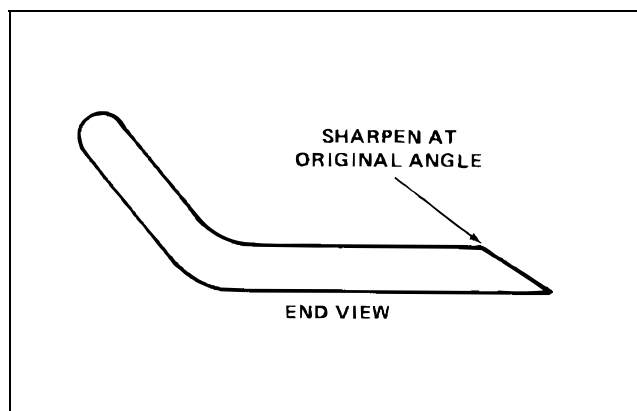


Figure 25

## Blade Spindle Service

### Removing Spindle and Bearings From Spindle Housing

1. Lower the cutting unit, shut the engine off and engage the parking brake.
2. Remove deck covers from top of cutting unit. Release belt tension (see Belt Tension Adjustment).
3. Remove belt from spindle to be serviced (see Belt Replacement).
4. If removing spindle with clutch, remove clutch rod. Unplug clutch electrical connector from harness.
5. Start the engine and raise the cutting unit. Turn the engine OFF and remove the key from the key switch. Engage locking latches to prevent cutting unit from falling accidentally.

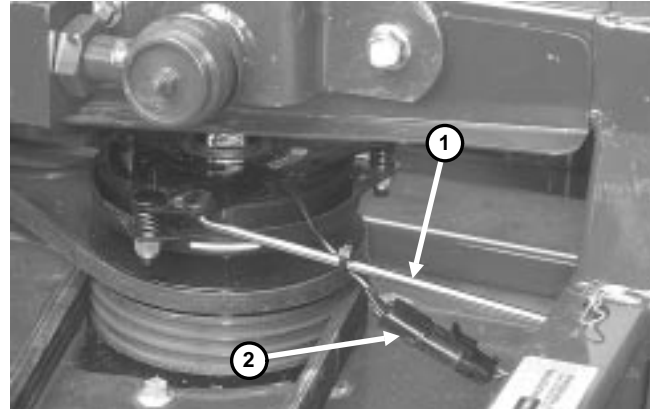


Figure 26

1. Clutch rod
2. Clutch electrical connector

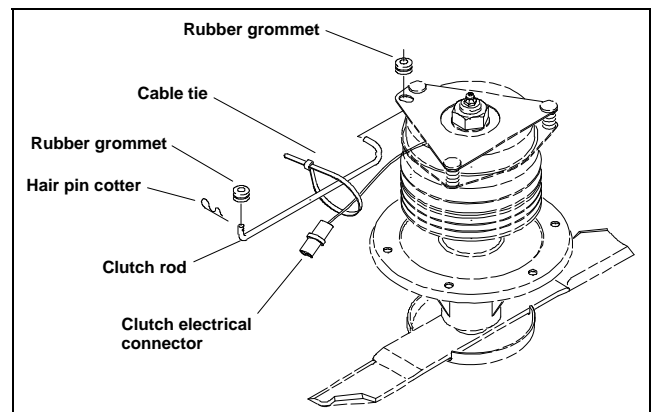


Figure 27

6. Remove the hex flange head screws (Item 8) and lock nuts (Item 10) securing spindle housing to deck. Slide spindle housing assembly out the bottom of the cutting unit.

7. Remove the nut (Item 2) and washer (Item 18) retaining the spindle pulley or clutch on the spindle shaft. Slide the pulley or clutch (Item 3), spacer (Item 5) and pulley (Item 6) off of the shaft. Make sure you account for the key (Item 4).

NOTE: There are three (3) different types of spindle housing assemblies. The type with the clutch is shown.

8. If the spindle shaft (Item 11) will be replaced, remove the blade bolt (Item 16), and blade (Item 13) from the spindle shaft. Otherwise, the blade may be left on the spindle shaft.

NOTE: Units with S/N below 30001 will have a hex bolt and flat washer securing the blade. Units with S/N 30001 & up will have a hex flange bolt securing the blade.

9. Press the spindle shaft (Item 11) out of the spindle housing (Item 9) using an arbor press. The spacer (Item 12) remains on the spindle shaft as the shaft is being removed.

10. The seals (Item 7) will be removed next; however, notice the lip of the seal. The lip of the upper seal faces inward, and the lip of the lower seal faces outward. Therefore, new seals must always be installed with the lip facing in the proper direction. Now remove the seals from spindle housing.

11. Allow the bearings and small spacer to fall out of the spindle housing.

12. Using a punch and hammer, drive both of the bearing cups out of the spindle housing. Also drive the large spacer out of the housing.

13. A large retaining ring is inside the spindle housing. The retaining ring is difficult to remove and it is recommended that it be left in place unless damaged.

**IMPORTANT:** If new bearings will be installed into a used spindle housing that has the original snap ring installed, discard the large snap ring that came with the bearings because it is not needed. However, new bearings with their matched spacer and snap ring must always be installed when the spindle housing is being replaced. Replacement bearings are sold only with a matched snap ring and spacer set. These parts cannot be purchased separately.

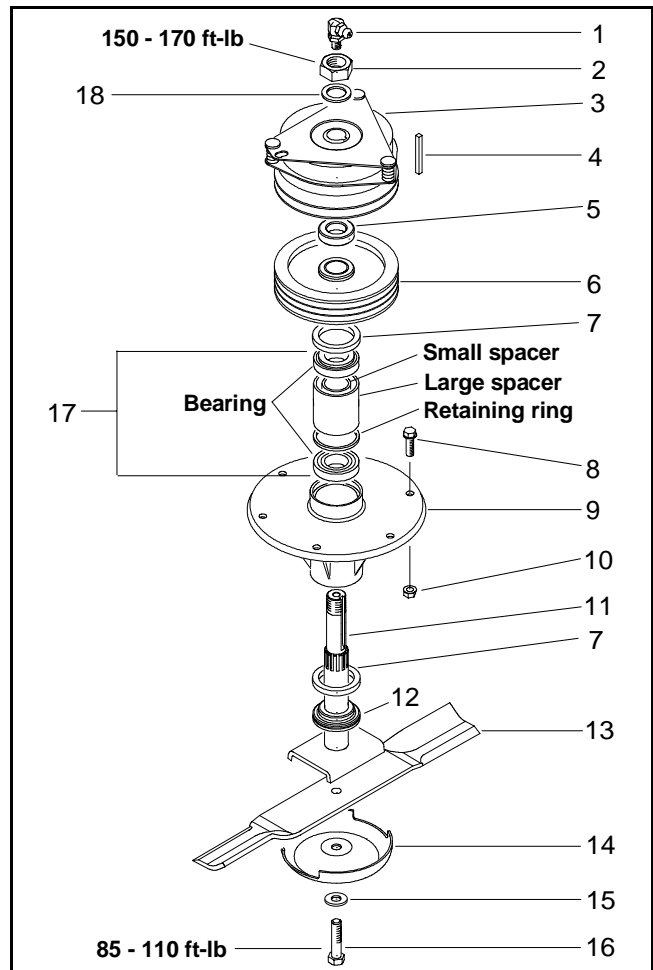


Figure 28

- |                          |                      |
|--------------------------|----------------------|
| 1. Grease fitting        | 11. Spindle shaft    |
| 2. Lock nut              | 12. Spindle spacer   |
| 3. Clutch                | 13. Blade            |
| 4. Square key            | 14. Anti-scalp cup   |
| 5. Spacer                | 15. Flat washer      |
| 6. Pulley                | 16. Blade bolt       |
| 7. Wave seal             | 17. Bearing assembly |
| 8. Hex flange head screw | 18. Washer           |
| 9. Spindle housing       |                      |
| 10. Flange nut           |                      |

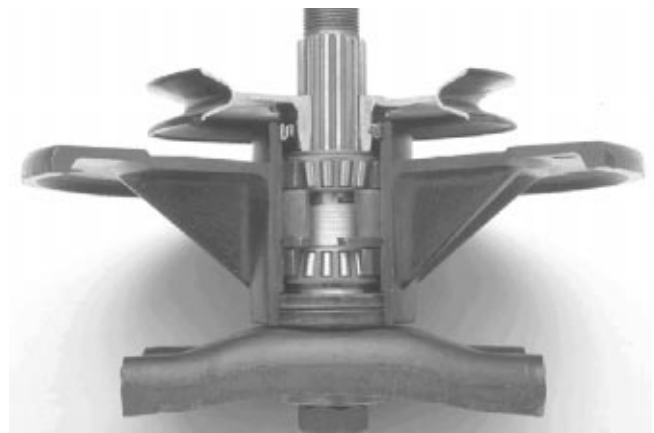


Figure 28a

## Installing Spindle, Bearings and Seals Into Spindle Housing

**IMPORTANT:** If a new spindle housing is being used, new bearings and the matched snap ring set must be installed; refer to step 1 below. Never use the old bearings, spacer, and snap ring with a new spindle housing. By contrast, use only new bearings with cups and spacer - not the large snap ring because it is not required - when installing bearings into a used spindle housing that still has a snap ring installed: refer to step 2 below.

1. Install the large retaining ring into the groove in the bore of the spindle housing. Make sure the retaining ring is seated in the groove.

2. Using an arbor press, push the large spacer into the top of the spindle housing; tightly against the snap ring. The spacer must contact the snap ring to be sure of the correct assembly of the parts.

3. Thoroughly oil the bearing cups and using an arbor press, push the bearing cups, smallest inside diameter first, into the top and bottom of the spindle housing. The top bearing cup must contact the spacer that was installed in step 2, and the bottom bearing cup must contact the snap ring to be sure of the correct assembly of parts. Insure that the assembly is correct by supporting the first cup and pressing the second against it.

4. Apply a film of grease on the lips of both seals, then install the bearing and the seal into the bottom of the spindle housing. Remember, the bottom seal must have the lip facing outward, not toward the inside of the spindle housing.

5. Check the spindle shaft to make sure it is free of burrs and nicks that could possibly cut the seals and thoroughly lubricate both the shaft and seal lips.

6. Slide the small, thick spacer into the spindle housing. Then install the bearing and seal into the top of the spindle housing. The lip of the seal must face inward.

7. Slide the spacer onto the spindle shaft. Carefully slide the spindle shaft through the spindle housing. The bottom seal and spacer fit together when the spindle is installed.

8. Attach grease gun to grease fitting and fill cavity with grease until grease starts to come out of lower seal.

9. Push the pulley, or pulley, spacer and clutch onto the spindle shaft and retain the parts together with the large flat washer and nut. Tighten the nut to 150 - 170 ft-lb and rotate the spindle shaft to be sure that the shaft rotates freely.

10. Slide the pulley end of the spindle assembly through the hole in the cutting unit. Mount the spindle assembly in place with the eight (8) hex flange head bolts and flange nuts.

11. Install the belt and adjust belt tension.

12. Install the clutch rod and connect the clutch electrical connector to the wire harness.

13. Install the belt covers.

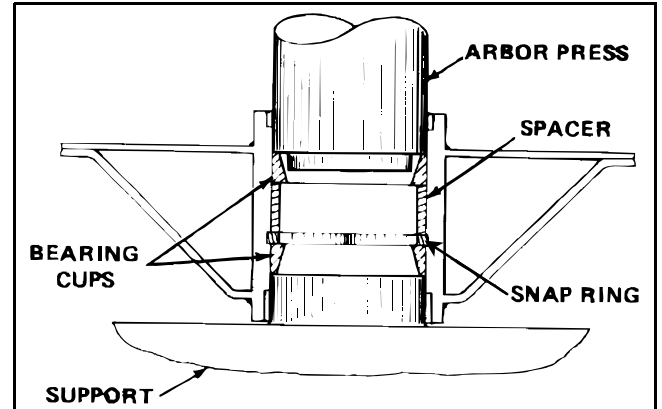


Figure 29

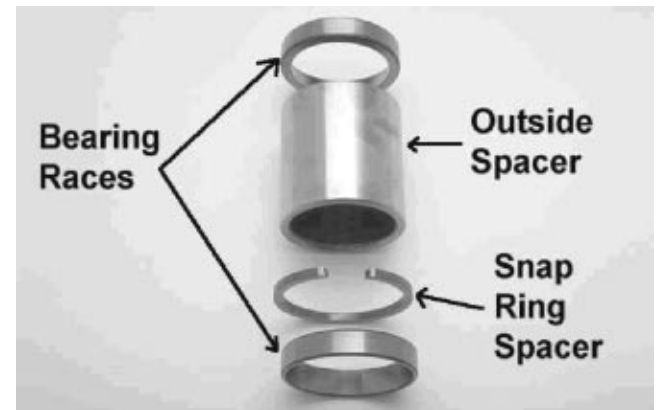


Figure 30

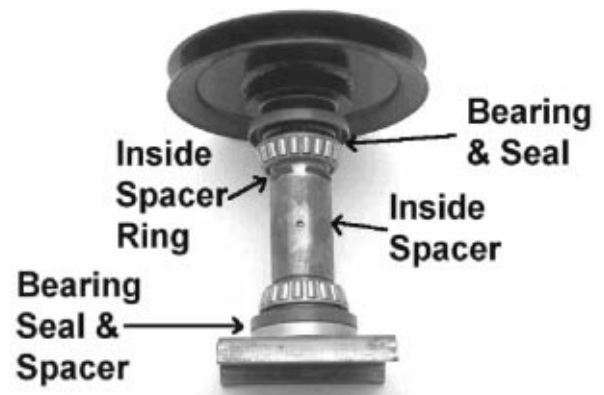


Figure 30a

## Gearbox Removal and Installation

### Removing Gearbox and Drive Pulley

1. To relieve tension on center deck belt, pull back on idler pulley until holes in idler adjuster tube and tube sleeve are aligned. Thread a 5/16-18 capscrew into holes retaining parts.

2. Disconnect drive shaft from gearbox input shaft.



#### CAUTION

**Do not start the engine and engage the P.T.O. when the P.T.O. shaft is not connected to the gearbox. If engine is started and the P.T.O. shaft is allowed to rotate, serious injury could result.**

4. Remove (2) flange head screws securing drive shaft cover to gearbox support and remove cover.

5. Remove four (4) sets of capscrews and nuts securing gearbox support to deck channels.

6. Remove gearbox support with gearbox attached.

7. Loosen two (2) capscrews securing pulley to gearbox output shaft and slide pulley off of gearbox output shaft.

8. Remove four (4) capscrews securing gearbox to gearbox support and remove gearbox.

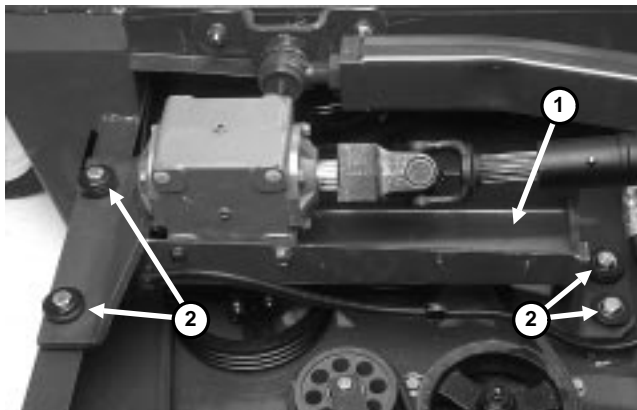


Figure 31

- 1. Gearbox support
- 2. Capscrews & nuts

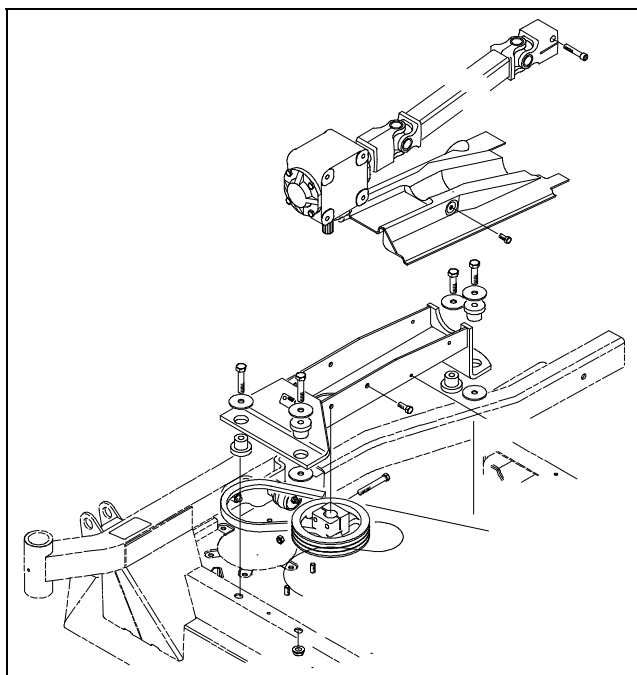


Figure 32



## Installing Gearbox and Drive Pulley

1. If replacing rubber mounts for gearbox support, use soapy water or lubricant to ease installation. Install left-hand mounts from top and right-hand mounts from bottom of bracket as shown.
2. Install gearbox to support bracket with with four (4) capscrews.
3. Slide pulley onto gearbox output shaft and secure by tightening two (2) capscrews.
4. Check the alignment of the gearbox pulley with adjacent spindle pulleys. Loosen and relocate the gearbox pulley, if necessary.
5. Mount rear end of gearbox support to deck channels. Leave capscrews and nuts loose. Lift front of gearbox support and install belt around gearbox pulley.
6. Secure front of gear box support to deck channels with capscrews and nuts. Tighten capscrews and nuts securing rear of gearbox support to deck channels.
7. Install drive shaft cover to gear box support with (4) flange head screws.
8. While holding idler pulley adjuster in position, carefully remove capscrew securing idler adjuster tube to tube sleeve. Allow idler pulley to release, tensioning belt.
9. Check idler pulley adjustment (see Belt Tension Adjustment).
10. Install belt covers.
11. Remove the gear box fill plug and check plug. Add SAE 80W90 API GL-5 gear lube until level is to the bottom of the check plug hole. Install plugs in gear box.

## Gearbox Repair

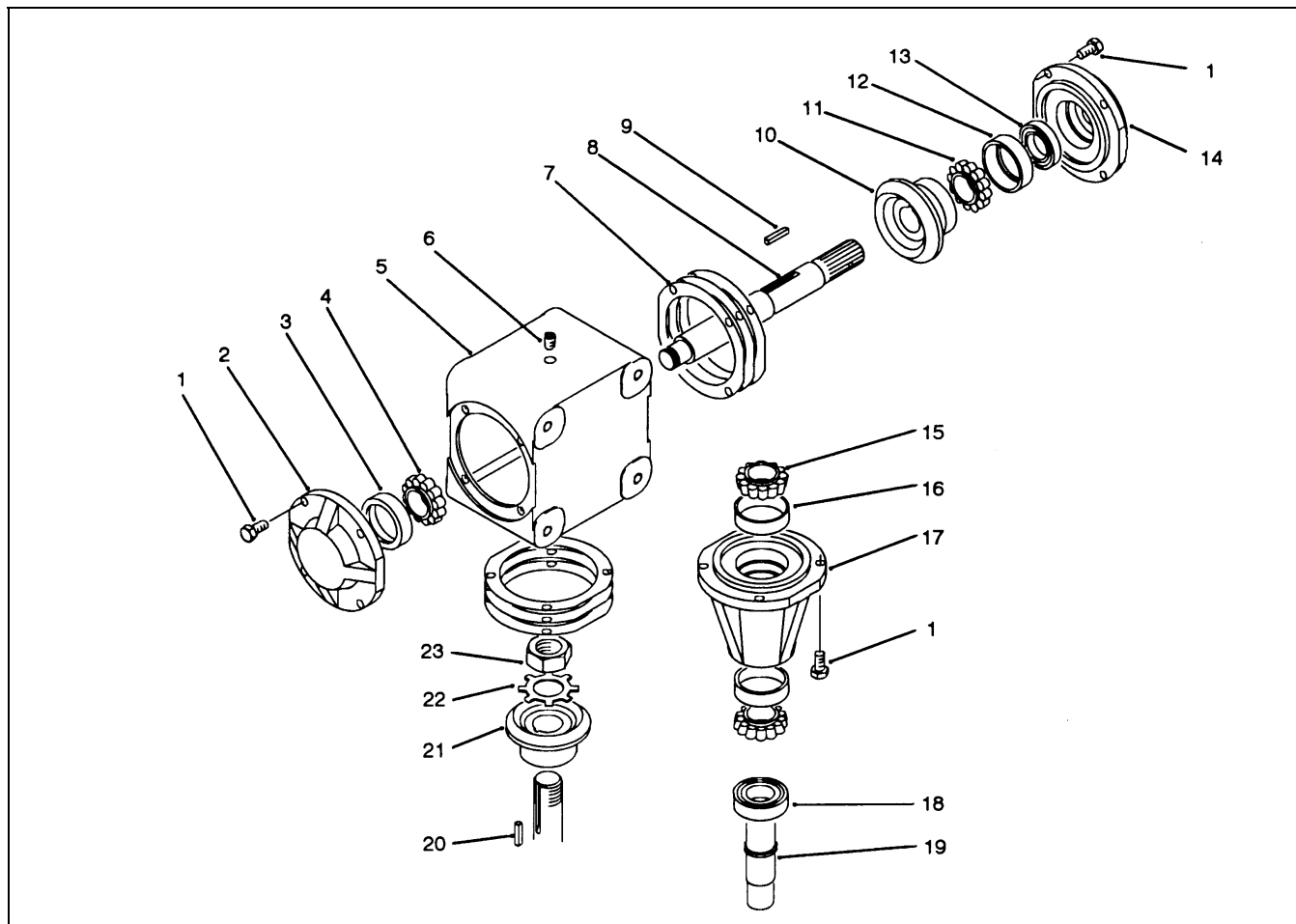


Figure 33

### Gear Box Disassembly

1. Drain lubricant from gear box.

2. Remove capscrews (Item 1) and lift out shaft and cap assemblies.

NOTE: Mark each gear (Item 10 and 21) so they are installed on the proper shaft (Item 8 or 19) when reassembled.

3. Remove thru cap (Item 14) and bearing cones (Item 4, 11) from shaft (Item 8).

4. Remove bearing cup (Item 12) from thru cap (Item 14) by putting a punch through the shaft bore and through the seal and then tapping against the back of the bearing cup until driven out of the cap.

5. If oil seal (Item 13) is removed, it will be destroyed. To remove the oil seal, cut it out of the bore with a screw driver or chisel. Be careful not to damage the bore.

6. Remove locknut (Item 23) and lockwasher (Item 22).

7. Press shaft (Item 19) back through seal end of hub (Item 17). When inner bearing cone (Item 15) is free, gear (Item 21) and key (Item 20) may be removed from the shaft. Remove other bearing cone and seal (Item 18).

8. To remove the bearing cups (Item 16) from the hub (Item 17) a slide hammer puller may be used, or if this is not available, the bearing cups may be knocked out with a punch by coming down through the opposite hub bore and tapping against the back side of the bearing cup until it comes out.

9. Remove the plugs (Item 6) from the housing.

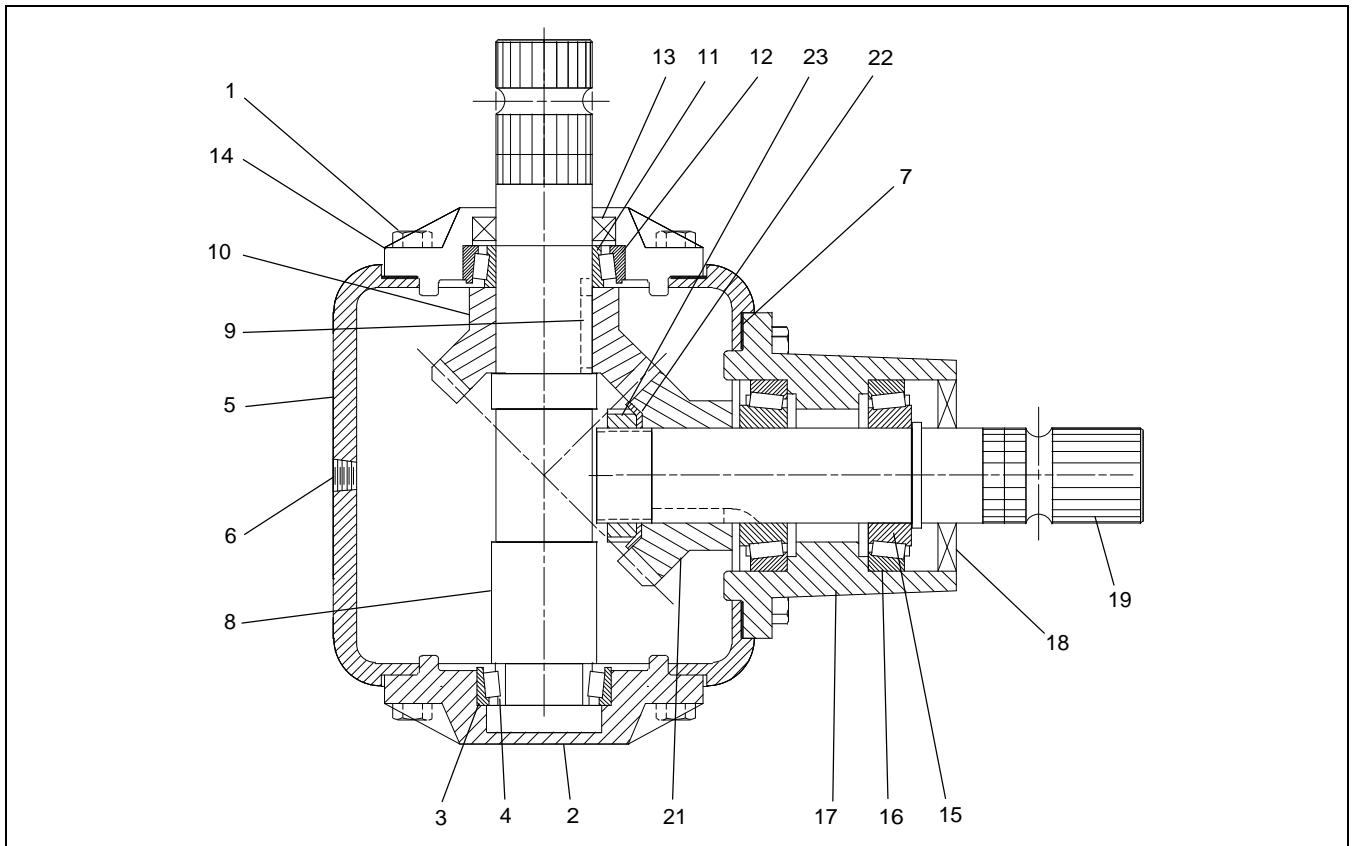


Figure 34

### Gearbox Pre-Assembly

**NOTE:** Apply a coating of lubricating oil to bearings before assembling.

1. Start with input shaft (Item 8) and put gear (Item 9) over shaft so tooth side is towards turned end of shaft. Align keyway in gear with keyway in shaft and install one of keys (Item 9) in keyway.

2. Press bearing cone (Item 4) over turned end of shaft.

3. Put bearing cone (Item 11) over other end of shaft and down against hub side of gear.

4. Put thru cap (Item 14) down, with machined surface facing up. Install a new seal (Item 13) into thru cap with open side toward machined side of thru cap.

5. Install bearing cup (Item 12) into cap (Item 2).

6. Take input shaft and gear assembly and wrap end of shaft with a piece of shim stock to keep from cutting oil seal on splines. Put cap assembly down over shaft so bearing cone (Item 11) on shaft mates with bearing cup (Item 12) in cap. Remove shim stock from shaft that was used to protect seal.

7. Press a bearing cone (Item 15) onto splined end of output shaft (Item 19).

8. Press a bearing cup (Item 16) into outer end of hub (Item 17).

9. Install shaft through outer end of hub so bearing cone on shaft mates with bearing cone in hub.

10. Press a bearing cup (Item 16) into inner end of hub (Item 17).

11. Press a bearing cone (Item 15) onto threaded end of shaft so it mates with bearing cone in hub.

12. Install gear (Item 21) over shaft so tooth side is towards threaded end of shaft. Align keyway in gear with keyway in shaft and install a key in keyway.

13. Install lockwasher (Item 22) and locknut (Item 23). Tighten locknut while turning shaft until there is no end play in shaft. Do not over tighten. shaft should have a very slight amount of bearing drag when turned.

14. Wrap splined end of output shaft (Item 19) with a piece of shim stock to prevent damage to oil seal. Install a new oil seal (Item 18) over shaft and into hub so open side is facing towards inside of hub.

15. Install plugs (Item 6) into tapped holes in housing.

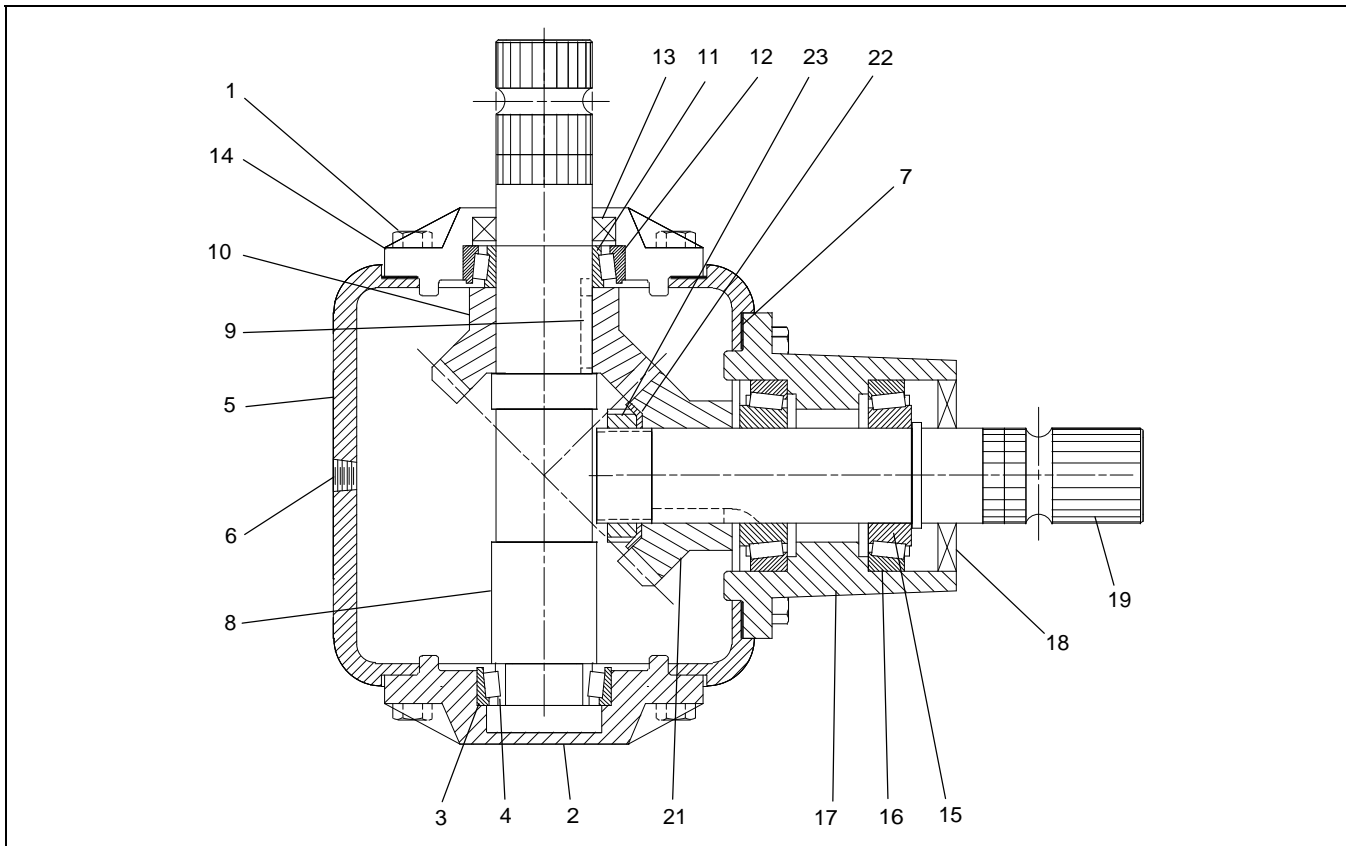


Figure 35

### Gearbox Final Assembly

1. Bearing drag for input shaft (Item 8) is adjusted by amount of gaskets (Item 7) used between thru cap (Item 14), and housing machined surfaces.

2. Put two 0.015 in. gaskets on machined surface of housing, then install shaft and thru cap assembly in housing so bearing cone (Item 4) on shaft assembly and bearing cup (Item 3) in blank cap (Item 2) are mating. Align holes in caps with holes in gaskets and housing.

3. Install capscrews and tighten.

4. shaft (Item 8) should have a very slight amount of bearing drag when turned. If shaft turns hard, cap must be removed and gasket(s) need to be added. If shaft has no bearing drag, or has end play, thru cap (Item 14) must be removed and gasket(s) taken out. thru cap must be adjusted to where shaft has no end play and only a slight amount of bearing drag.

5. Gear lash is adjusted by amount of gaskets (Item 7) used between hub (Item 17), and housing machined surfaces.

6. Put two 0.015 in. gaskets on machined surface of housing, then install shaft and hub assembly in housing. Align holes in hub with holes in gaskets and housing.

7. Install capscrews and tighten.

8. output shaft (Item 19) should turn freely with a slight amount of bearing drag and no sticking or binding. If shaft turns hard, hub (Item 17) must be removed and gasket(s) need to be added. If shaft has free play (backlash), cap must be removed and gasket(s) taken out. hub must be adjusted to where shaft has minimal backlash and only a slight amount of bearing drag. assembly must turn freely without sticking or binding.

9. After installing gear box on cutting unit, fill it with SAE 80W90 API GL-5 lubricant to level of check plug.

## Deck Clutch Service

Failure to get clutch engagement would likely be caused by a clutch air gap that is too large (see Clutch Adjustment), a circuit fault in clutch electromagnet, or other electrical problem (see Troubleshooting section of Chapter 5 - Electrical System).

NOTE: It is recommended that clutch be serviced in sub-assemblies, however, some individual parts of clutch can be replaced.

1. Follow steps 1 - 7 under Blade Spindle Service to remove clutch.

2. Remove three (3) locknuts (Item 9) and springs (Item 10).

3. Separate clutch into two halves; field rotor assembly (Items 1 - 4) and armature and pulley assembly (Items 5 - 8).

4. To replace pulley bearing (Item 7):

A. Remove retaining ring (Item 8).

B. Put armature and pulley assembly, pulley side down, in an arbor press. Press on bearing collar (Item 6) to remove bearing and collar. If bearing is removed, it MUST be replaced.

C. Press collar out of bearing.

D. Make sure both inside and outside race of new bearing is on a flat surface and press collar into bearing.

E. Put armature and pulley assembly in arbor press, pulley side up. Put spacers in three (3) locations between pulley and armature plate to prevent damage to springs. Three (3) stacks of flat washers can be used for spacers. Make sure extended part of collar is facing down and press on outer bearing race to install bearing and collar.

F. Install retaining ring.

5. Assemble clutch halves, install on spindle shaft and adjust air gap (see Clutch Adjustment and Clutch Replacement).

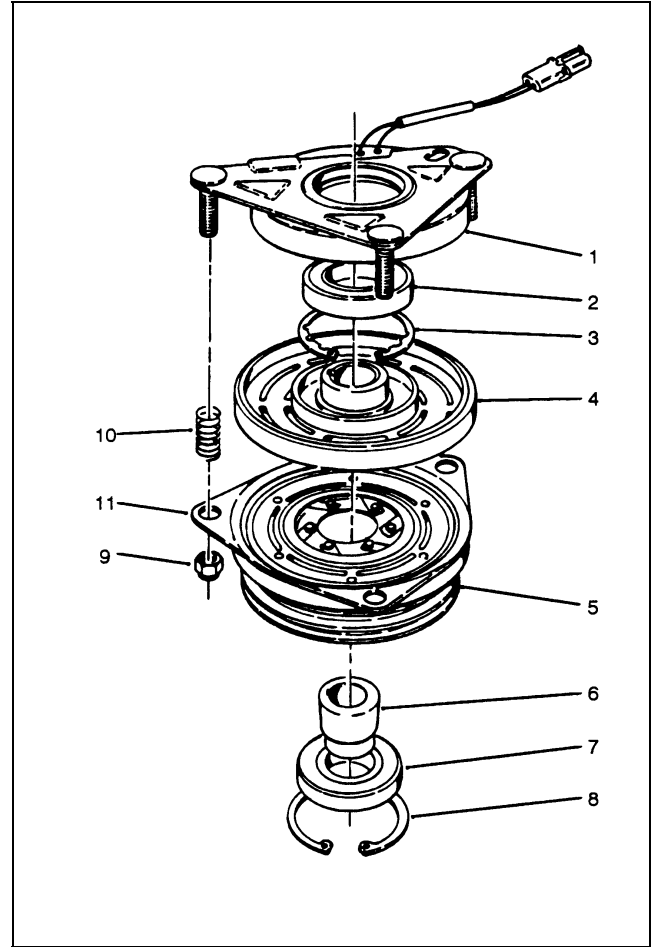


Figure 36

- |   |                   |
|---|-------------------|
| 1. Field rotor ass'y<br>(Items 1 - 4)       | 6. Bearing collar |
| 2. Field bearing                            | 7. Pulley bearing |
| 3. Retaining ring                           | 8. Retaining ring |
| 4. Field coil ass'y                         | 9. Locknut        |
| 5. Armature & pulley ass'y<br>(Items 5 - 8) | 10. Spring        |
|   | 11. Brake plate   |

## Wing Pivot Arm Installation and Ball Joint Service

When assembling wing pivot arms, adjust ball joint thread engagement to get a length of 8.06" for proper blade plane setting, then tighten jam nut (also see Blade Adjustment).

**IMPORTANT:** Before installing wing pivot arms, clean tapered surfaces of ball joints and mounting bosses on deck with solvent degreaser.

Apply Loctite 242 or equivalent to nut securing ball joint and tighten to a torque of 150 - 180 ft-lb. Make sure two (2) flat washers are installed under nut.

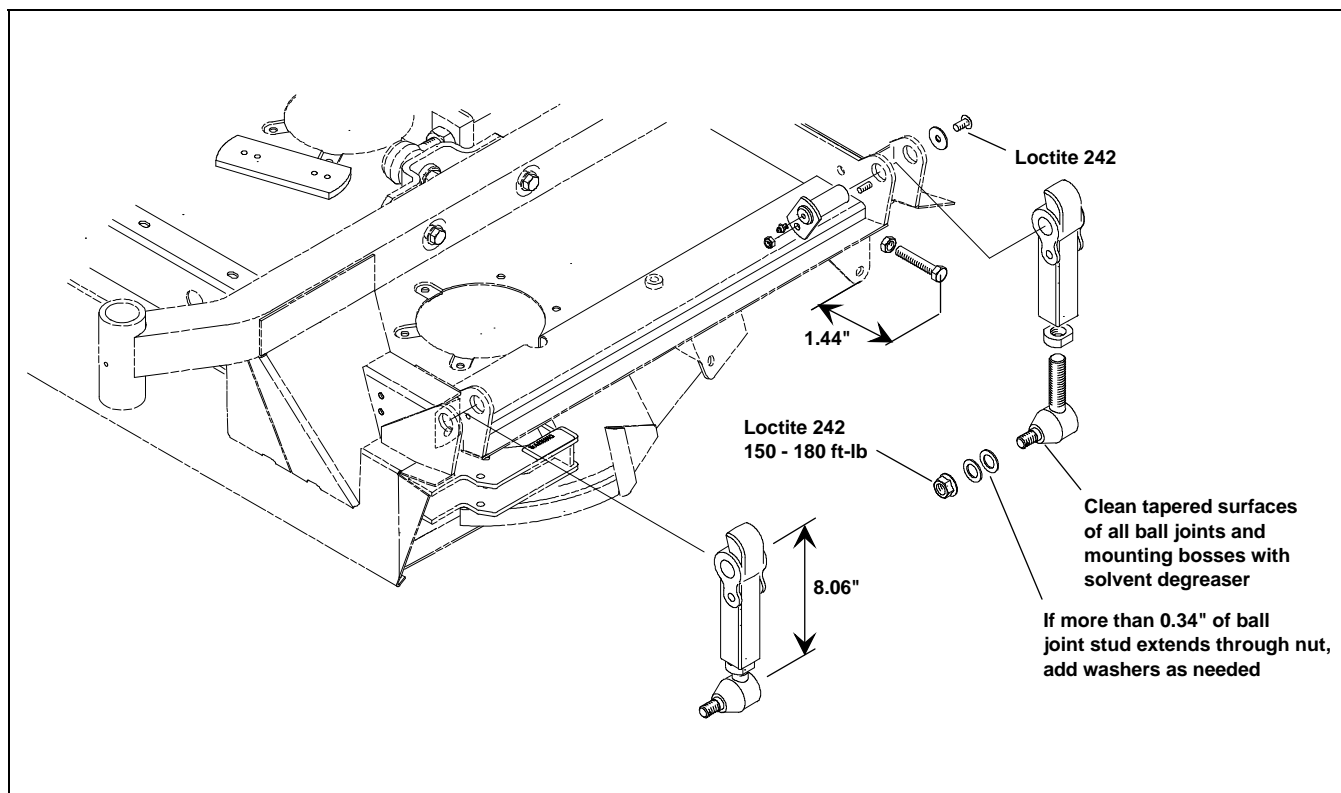


Figure 37

## Safety Door Service

When assembling safety door actuator, adjust threaded rod to get a dimension of 6.25" between center of each ball joint.

Apply Loctite 242 or equivalent to threads of each ball joint before installing in deck and safety door.

After installing actuator, adjust threaded rod so lower edge of door is even to 0.25" higher than lower edge of door guide when wing decks are in fully raised (transport) position, then tighten jam nuts (see Safety Door Adjustment).

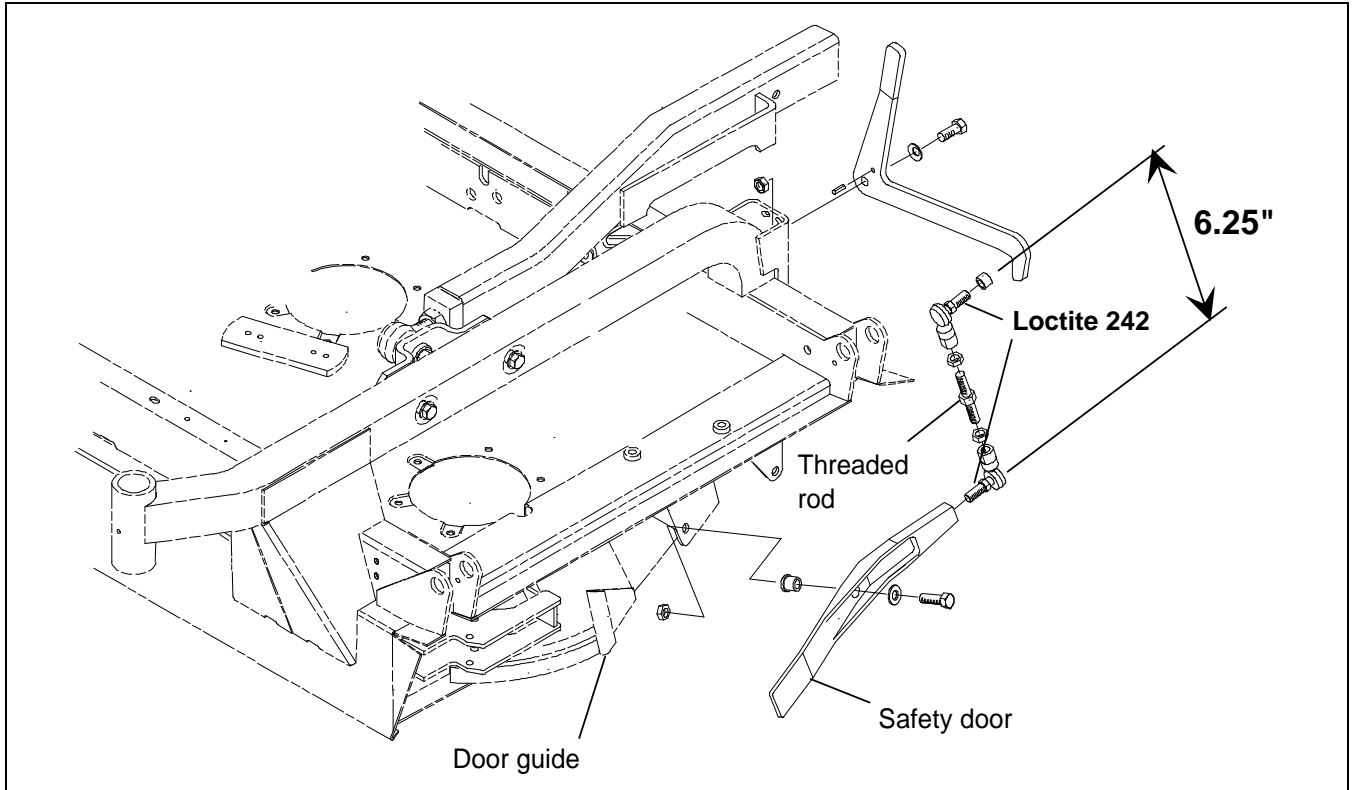


Figure 38

## Wing Cylinder Installation and Ball Joint Service

When assembling wing cylinders, adjust ball joint thread engagement to get a retracted length of 17.00" to eliminate movement of wing decks in the fully raised (transport) position, then tighten jam nut.

**IMPORTANT: Before installing wing cylinders, clean tapered surfaces of ball joints and mounting bosses on deck with solvent degreaser.**

Apply Loctite 242 or equivalent to nuts securing ball joints and tighten to a torque of 150 - 180 ft-lb. Make sure two (2) flat washers are installed under each nut.

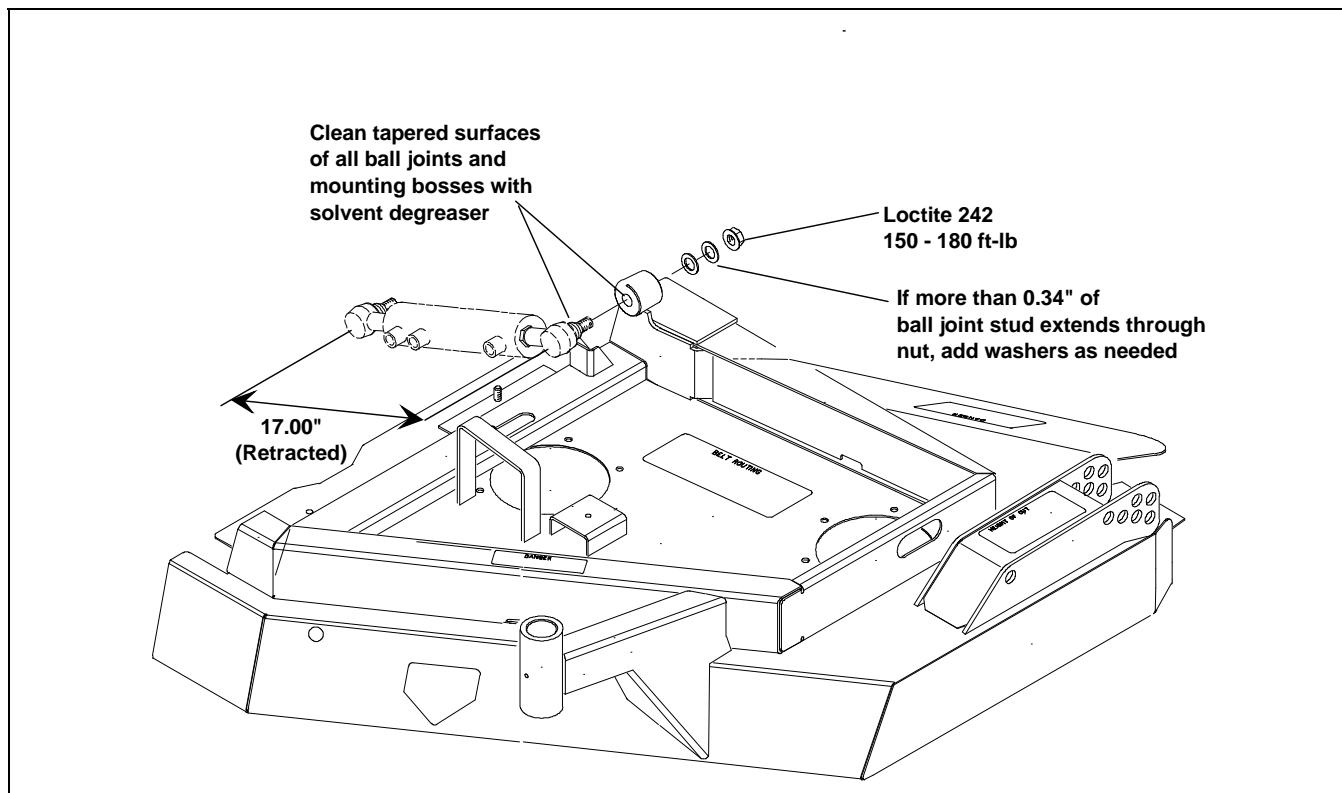


Figure 39



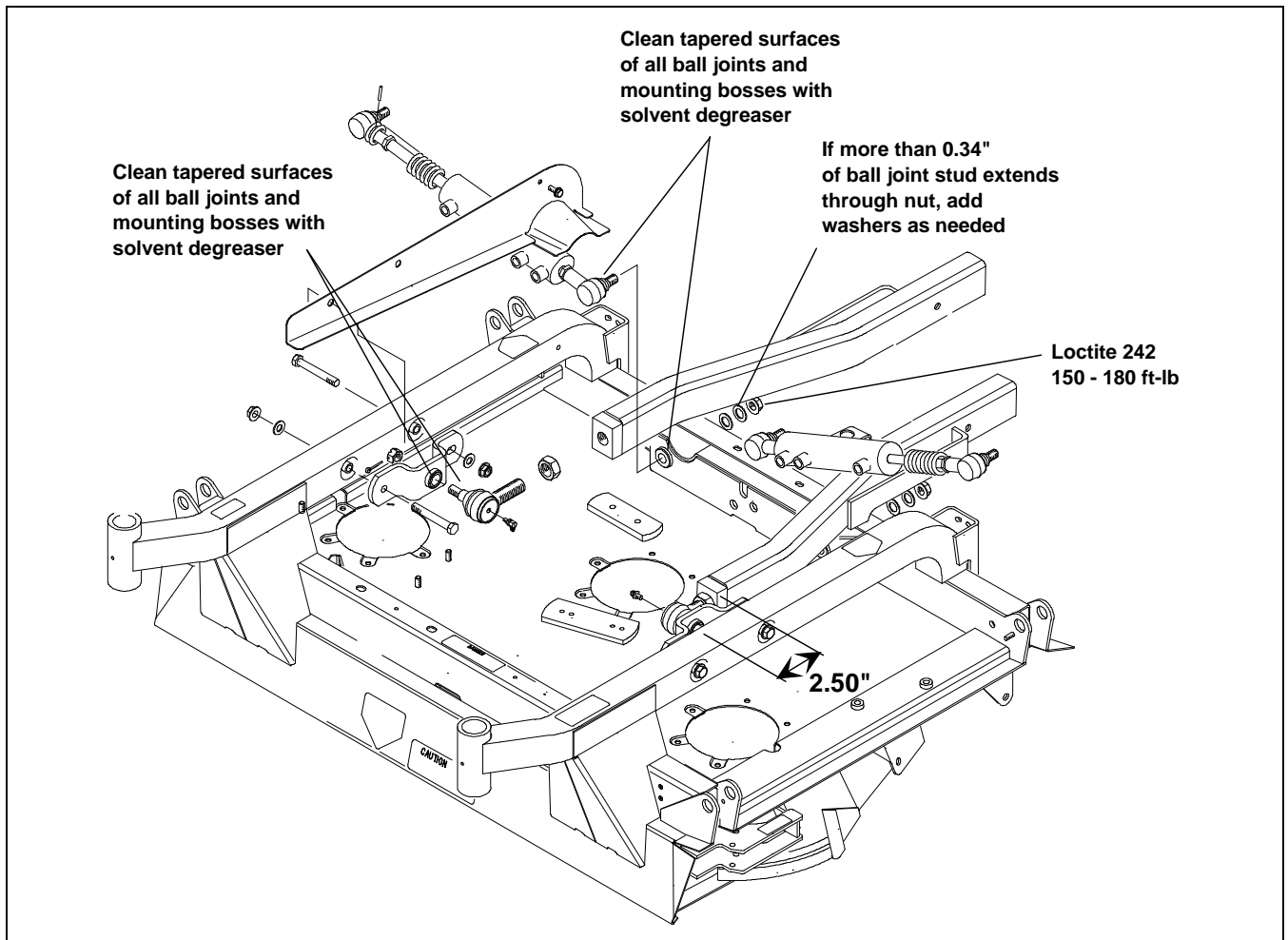


Figure 40

## Center Deck Lift Arm Ball Joint Service

When installing center deck lift arm ball joints (Fig. 40), adjust ball joint thread engagement to get a dimension of  $2.50 \pm 0.12$ " from the lift arm end to center of ball joint. Tighten jam nut after ball joint is fastened to deck.

**IMPORTANT:** Before install ball joints to deck, clean tapered surfaces of ball joints and mounting bosses on deck with solvent degreaser.

## Idler Pulley Service

Apply Loctite 242 or equivalent to threads of bolt securing idler pulley to deck. Tighten bolt to a torque of 35 to 40 ft-lb.

When installing V-groove idler pulleys, make sure bolt heads are facing down.

Make sure center idler pulley on center deck is installed in hole closest to edge of pulley support. Install in adjacent hole if using optional high speed (larger diameter) gearbox pulley.

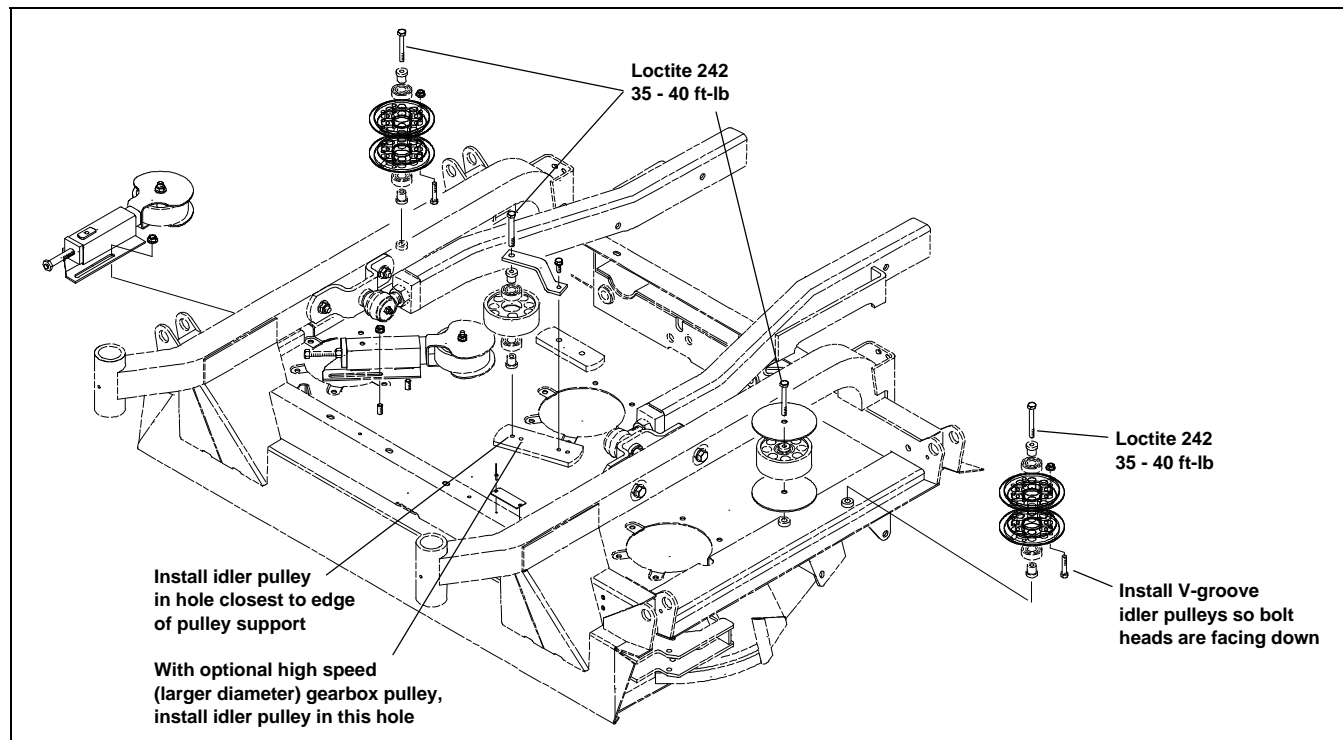


Figure 41

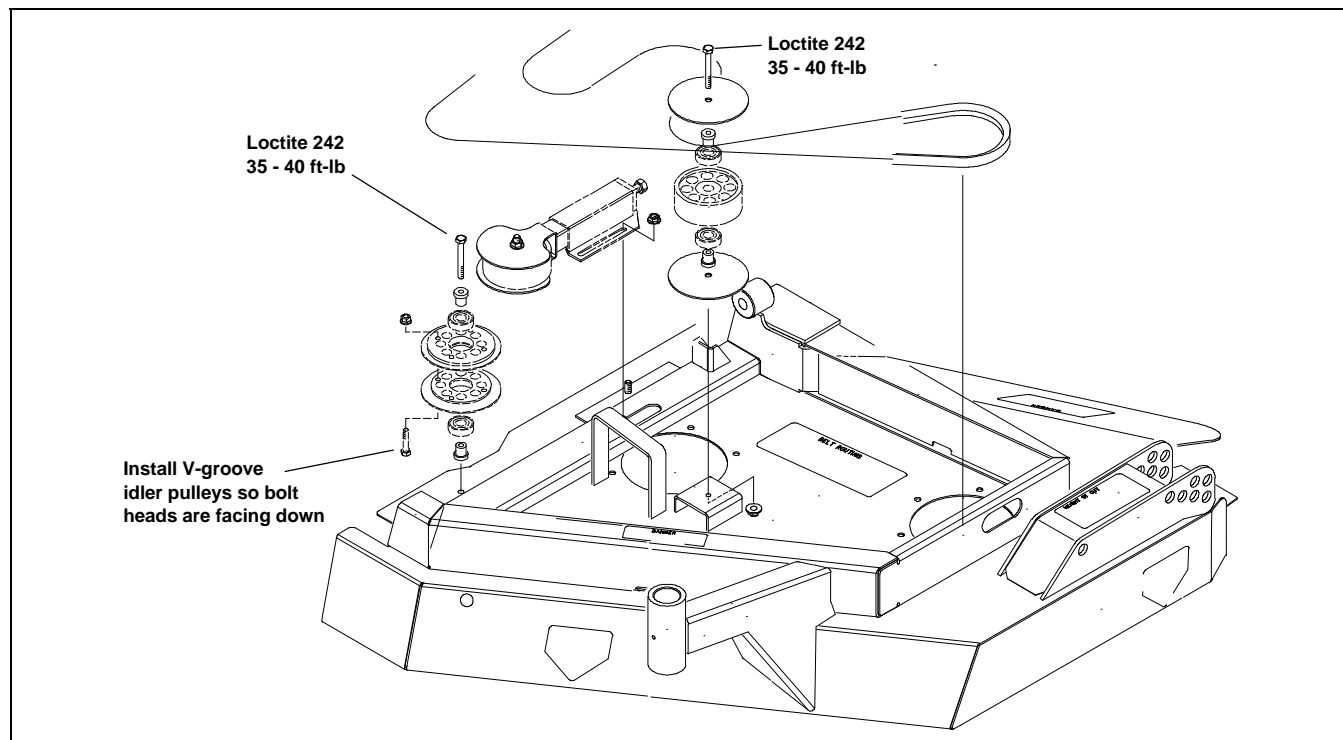


Figure 42

## Wing Deck Spring Loaded Locking Mechanism Service



### WARNING

**This mechanism is spring loaded. Use proper disassembly procedures to prevent possible personal injury.**

NOTE: Some early production units were not equipped with rod caps and socket head screws. These parts must be used for the following procedure. Order Toro Parts 92-4036, Cap – Rod and 92-4037, Screw – Hex Socket Hd.

#### To disassemble:

1. Remove socket head screw.
2. Reverse rod cap so large diameter end is facing spring support rod, then re-install socket head screw.
3. Remove cotter pin from large clevis pin in center of lock. Tighten socket head screw, pulling spring support

rod back, until large clevis pin is loose, then remove clevis pin.

4. Remove socket head screw to relieve spring tension and remove locking mechanism.

#### To install locking mechanism:

1. Replace worn or damaged parts in mechanism.
2. Place rod cap on bracket so large end is facing spring support rod and install socket head screw.
3. Tighten socket head screw, pulling spring support rod back, until lock pivot is aligned with holes in deck, then install clevis pin and cotter pin to secure spring loaded locking mechanism.
4. Remove socket head screw. Reverse rod cap so small end is facing spring support rod, apply Never-Seez or equivalent to threads of socket head screw and install screw to secure rod cap on end of spring support rod.

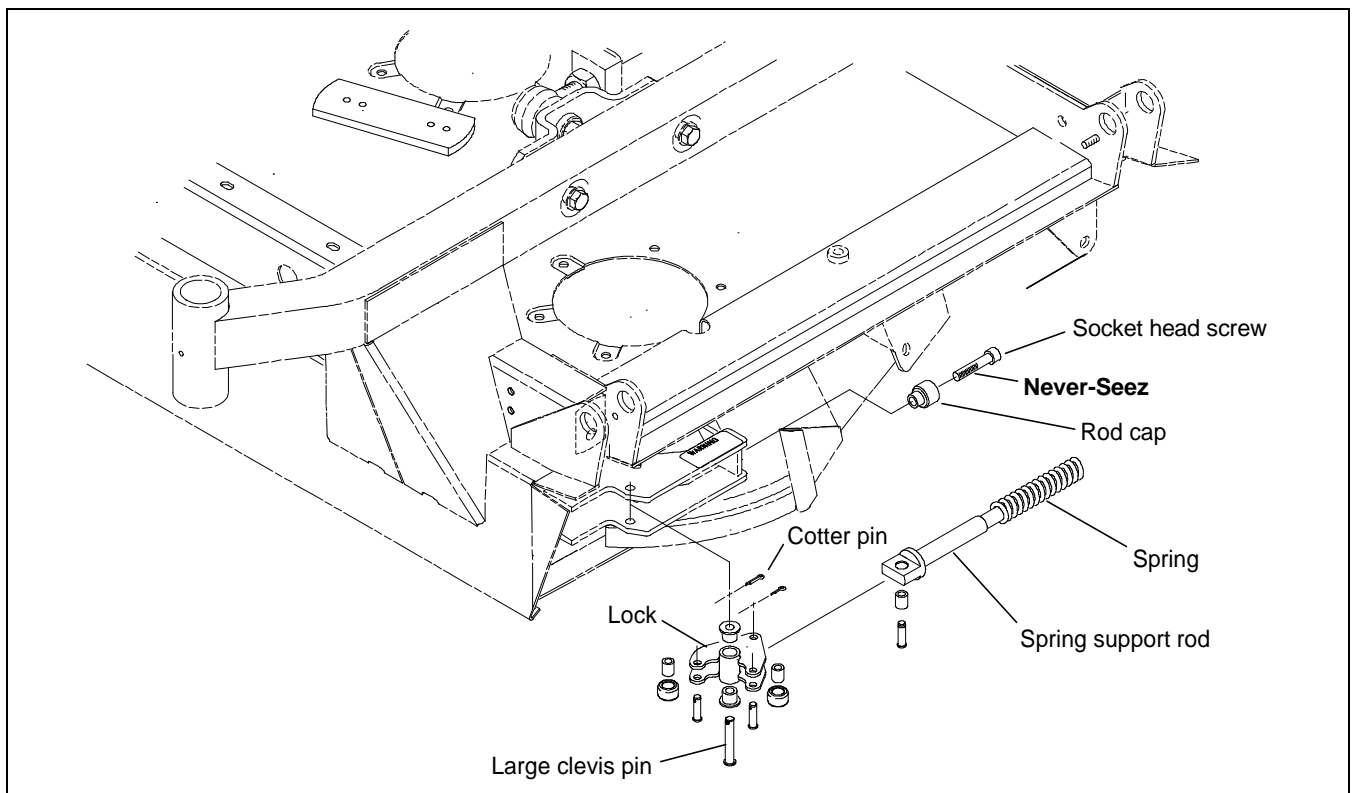


Figure 43

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